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Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-2} s^{-1}—and at high pressure, 3:1118 (UCRL–79012)
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Volume 3, Number 6, March 31, 1978

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

11410 (ORNL—5327) **Coal Technology Program quarterly progress report for the period ending June 30, 1977.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 253p. Dep. NTIS, PC A12/MF A01.

Results of ORNL's research efforts in the following areas are described: Mock-up experiments, hydrocarbonization, carbonization of residues, engineering support of in-situ coal gasification, pressurized carbonization, coal-solvent-hydrogen mixing, mathematical models of coal conversion processes, synthetic fuels process research digest, industrial coal conversion equipment capability, large oxygen plant feasibility study, heat recovery processes, hot-gas purification, flash hydropyrolysis, comparative evaluation of low Btu gasification process, coal combustion, advanced power conversion systems, evaluation of coal liquefaction processes, high Btu gasification processes, fuel gas purification, coal prices and transport charges, environmental effects of natural gas pipelines, environmental monitoring handbook, materials technology, alkali metal vapor topping cycles, coal-fired alkali metal power systems, equipment tests and test facilities, chemical research and development, air and water pollution and pollutant transport from coke ovens, etc. (LTN)

11411 **'Favorable winds' for brown coal. 25 years of Deutscher Braunkohlen-Industrieverein in Cologne.** Baltsch, H.H. *Energiewirtsch. Tagesfragen;* **27**: No. 6, 425-426(Jun 1977). (In German).

A summary is presented of lectures held on the occasion of the silver jubilee of the Deutscher Braunkohlen-Industrieverein.

11412 **Increasing interest in coal in the USA.** *Chem. Ind. (Dusseldorf);* **100**: No. 4, 209(Apr 1977). (In German).

PROCESSING

CARBONIZATION

REFER ALSO TO CITATION(S) 11469, 11486

11413 **Kinetics of graphitization within the first minute of heat treatment.** Fitzer, E.; Weisenburger, S. (Univ., Karlsruhe, Ger.). *Carbon;* **14**: 323-327(1976).

To study the kinetics of graphitization within the first minute of heat treatment, an in situ X-ray technique was used which allows fast heating of the sample and measurements after 50 to 60 sec of heat treatment. Experimental data and extrapolation procedures were combined to obtain the non-isothermal contraction curve of interlayer spacing between 1700 and 2500°C. Evaluation of these data, which represents the kinetic behavior within the first 20 to 30 sec of heat treatment, leads to an activation energy of 0.4 eV which is relatively low compared with values found in the later stage of graphitizatization (7 to 10 eV for heat treatment times above 1 to 2 min up to several hours). Conclusions are drawn in respect to the mechanism of the first steps of graphitization.

11414 **Alternatives to the oil-from-coal process.** Stander, W.J. *S. Afr. Chem. Process.;* **25**: 27(Nov 1975).

Carbonization of coal to produce a maximum amount of tar was studied using a fluidized bed unit capable of processing approximately 3 kg/hr of coal. Higher yields of tarry liquids were obtained from a low-rank coal having 40% volatiles than from a Witbank middlings coal having 28% volatiles content. The tar from the low-rank coal was a free-flowing black oil, while the middlings coal produced a viscous tar.

11415 **Multi-stage activation of brown-coal chars with oxygen.** Tomkow, K.; Siemieniewska, T.; Jankowska, A.; Czechowski, F. (Tech Univ of Wroclaw, Pol). *Fuel;* **56**: No. 3, 266-270(Jul 1977).

Activation of xylitic brown-coal coke XBC 900 with water vapor and carbon dioxide, when modified by partial replacement of the basic activating agent with 10% oxygen at a lower temperature, results in products with an increased microporosity. Temperature of carbonization of the brown-coal char has a strong effect on the possiblity of pore development through further activation. Multi-stage oxygen activation of xylitic brown-coal semicoke XBC 500 produces a material with a smaller micropore volume and a lower surface area than that of xylitic brown-coal coke XBC 900 similarly activated. 11 refs.

11416 **Method for the production of formed coke from non baking or weak baking coal.** Gorin, E.; Jasulaitis, W.A.; Theodore, F.W.; Wasson, G.E. (to Consolidation Coal Co., Pittsburgh, Pa. (USA)). German(FRG) Patent 2,630,527/A/. 27 Jan 1977. 11p. (In German).

To produce formed coke, which is used in blast furnaces, the following process is proposed: Non-coking or poorly coking coal is subjected to solvent extraction in the presence of hydrogen at high temperature and pressures. The product formed, which contains a mixture of coal extracts and undissolved solids, from which the solvent may or may not have been removed, is mixed with dispersed hydrocarbonaceous solids. The agglomerate is formed from this mixture and this is subjected to a low temperature carbonisation process. The green formed coke obtained in this way is then calcined in order to produce formed coke.

11417 **Method for the production of high quality coke from soft brown coal by a single step process.** Krug, H.; Naundorf, W.; Brueckner, D.; Klose, E.; Teubel, J.; Rentrop, K.H. (to Brennstoffinstitut Freiberg (German Democratic Republic)). German(FRG) Patent 2,627,429/A/. 13 Jan 1977. 4p. (In German).

The addition of a coking accessory material is proposed in the production of high quality coke from soft brown coal (lignite) which should lead to the formation of a more stable coking of dry brown coal. Sulphide off-cuts, pulverised sulphide off-cuts and modified tar are named as coking accessories. The coking accessories can be activated by the addition of 2% sulfuric acid or hydrochloric acid, sulfur resins or salt solutions. The briquetting of the fluid briquetting material and the coking accessory contained in it is carried out on channel-shaped forming presses.

11418 **Agglomeration 77. Volume 2.** Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977). 591p. (CONF-770312—P2).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977).

The Second International Symposium on Agglomeration was sponsored by the AIME and held at Atlanta, Ga., March 6-10, 1977. Seven papers from Volume 2 of the Proceedings dealing with the agglomeration of coal fines, formed coke processes (and including some papers related to other coking processes, smokeless fuels, etc.) and blast furnace operating tests on the coke produced have been entered individually into EDB and ERA. (LTN)

11419 **Utilization of non-coking coal for metallurgical coke manufacture.** Sugasawa, K.; Sunami, Y.; Kanoh, T.; Tsuyuguchi, M. pp 955-969 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

At Sumitomo Metal Industries, technologies for manufacturing metallurgical coke have been developed under the names of Sumicoal System and DKS formed coke processes. Sumicoal System is the process utilizing approximately 70% conventional fine coal,

30% briquettes charge, and 2 to 3% caking substance. This technology was industrialized in 1975, and now the blending ratio of non-coking coal has reached up to 20%. On the other hand, a large scale demonstration plant using the DKS process was constructed and operated over one year. As the result of that test, it is thought that the DKS process has also reached the stage of industrialization. This paper describes these new coking technologies.

11420 Ancit process. Hermann, W.; Schmit, R. (Eschweiler Bergwerks-Verein, Luxembourg). pp 970-995 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

The ancit-process of the Eschweiler Bergwerks-Verein, an affiliate Company of ARBED S.A., Luxembourg, was developed in principle by the Dutch State Mines, Limburg, in the mid-50's with the aim of producing a smokeless domestic fuel on the basis of low volatile hard coal. In 1967, the EBV erected a 10 t/h large-size pilot plant along these principles in the Aachen mining district and further developed the acquired know-how. In hardly 10 years more than 650,000 t of ancit briquettes with unit weights between 17 and 100 grams were produced and in the meantime on-stream rates of over 85% of the yearly utilization hours have been reached. More than 10 blast furnace trial runs involving substitution rates up to 100 p.c. ancit have proved the suitability of ancit as a metallurgical fuel both for a burden with a high and a poor iron content. Construction work for a minor process-step to enable processing of coal with a higher content of volatile matter is finished and results are expected by summer this year. A pilot plant with a 30 t/h capacity working on a low-volatile coal basis is planned.

11421 HBNPC formcoke tests in Usinor blast furnaces. Cordier, J.A.; Rochas, R. pp 996-1011 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

USINOR has conducted four blast furnace tests with formcoke made from marginal coals in the pilot plant of HBNPC ("H. B. N." process) in four different blast furnaces of various sizes and with medium and high grade burdens. The tests in which up to 30% of the blast furnace fuel burden was replaced by HBN formcoke yielded good results on furnaces ranging in hearth diameters from 5.6 to 9.5 m. The tests demonstrated that the slight increase of pressure drop in the stack did not prevent smooth operation at record production rates with the same blowers; the total coke rate was not significantly affected, but there was a slight increase of the calorific value of the top gas; and the properties of the hot formcoke are satisfactory as seen from the samples withdrawn at the tuyeres and tapholes. At the end of the two months test on BF n° 2 of Dunkerque, the hearth was as permeable and clean as with good standard coke. Our conclusion is that HBNPC formcoke made from lean coals is an adequate substitute for conventional coke in the range of 20 to 40% replacement, which is of interest to USINOR.

11422 Blast furnace test with 20,000 net tons of FMC formcoke at Inland's No. 5 blast furnace. Strangway, P.K.; Holowaty, M.O. (Inland Steel Co., East Chicago, IN). pp 1012-1050 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

During 1973, a 20,000 net ton (18,100 metric ton) formcoke test was carried out at Inland's 26.5-foot (8.08-meter) hearth diameter on No. 5 Blast Furnace. The formcoke briquettes were produced from Elkol coal by FMC at their pilot plant in Kemmerer, Wyoming, and shipped to Inland in open railroad cars. During the formcoke test period, the regular coke skip loads were gradually replaced with skips of formcoke until, after a three-week period, the replacement ratio reached 80%. The furnace operated smoothly and quality hot metal was produced. The burden remained permeable and it was possible to maintain wind rates of over 100,000 scfm (47 Nm^3/s) without significant blast pressure increases. Dusting from the formcoke was not a problem either in the stockhouse or in the top gas. The formcoke briquettes maintained their original shape and density as they descended through the furnace. When the 80% replacement level had been reached, the inwall temperatures became higher than normal (about 2000°F (1090°C)) and followed an unusual steady pattern. In addition, the top gas temperature became higher than normal, and the hot metal analyses and temperatures began to fluctuate unacceptably. Since it was felt to be unsafe to operate the furnace for an extended period of time with the inwall temperatures at the high level, a decision was made to remove the formcoke from the furnace. The inwall temperatures returned to normal and the remaining 3,800 net tons (3450 metric tons) of formcoke were used in the furnace at a nominal 40% replacement level for five continuous days. The test was successful in proving that formcoke can replace up to about 50% of the regular coke in a large furnace operating at high wind rates.

11423 Recent work on preheating at the British Carbonization Research Association. Graham, J.P.; Pater, V.J. (British Carbonization Research Association, Wingerworth, Eng.). pp 1051-1070 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

The authors present background information with respect to preheating and its development and describe the facilities available at the British Carbonization Research Association. The results obtained at BCRA, including those collected during commissioning of the new plant at BCRA, are summarized. The enlarged test-plant facilities embrace both 10-t (4.2 m high) and 17-t (6.5 m high) test ovens and two types of preheater, the preheated coal being charged by either gravity or pipeline. During the commissioning of the new equipment, an extensive program on preheating was initiated and the results obtained so far are included. These cover tests on wet and preheated coals and commercial blends, the use of Rosin- and Cerchar-type preheaters and charging by both gravity and pipeline systems to the 10-t and 17-t ovens. Accordingly, for the first time a direct comparison is possible of both the performances of the plants and the qualities of the respective products. The paper also outlines the findings from a study of the carryover of solids during the charging of preheated coal and of the treatment of those solids.

11424 Method for the production of coke. Gray, M.D.; Kimber, G.M. (to Coal Industry (Patents) Ltd., London (UK)). German(FRG) Patent 2,624,389/A/. 23 Dec 1976. 9p. (In German).

The invention relates to a process for the production of coke with low impurities. The coke is the basic material for electrodes, which are used in the aluminium industry. For this purpose carbon is extracted with a highly aromatic hydrocarbon at a temperature of at least 350°C. The insoluble part is coked at above 480°C. Details of the extraction process and separation of the extract remnant are given. The analysis of the coal used and the carbon extract types of coke are given.

11425 Method for producing agglomerates for the fabrication of formed coke. Gorin, E. (to Consolidation Coal Co., Pittsburgh, Pa. (USA)). German(FRG) Patent 1,671,366/C/. 9 Dec 1976. 4p. (In German).

A process for the production of agglomerates from poorly baking or non-baking coal is described, where the initial coal is rolled with a hydrocarbon binding material in a rotating furnace. Part of the required binding material is automatically produced in the rotating furnace at the same time. At least part of the initial coal is extracted at high temperature by a solvent, the extract is separated from the solvent and added to the rotating furnace. Variations of this process are the purpose of the invention.

11426 Process for the production of coke of low apparent specific gravity. Lohrmann, H.; Petak, H. (to Saarbergwerke A.G., Saarbruecken (Germany, F.R.)). German(FRG) Patent 1,783,189/B/. 25 Nov 1976. 2p. (In German).

To produce coke of low apparent specific gravity, steam coal, brown coal (lignite), volatile coking coal, peat, a melt product produced at a temperature of up to 450°C from fine ground coking coal and briquetting pitch, hard pitch or high melting point bitumen, are mixed, pressed and coked at normal coking temperature. Details of grain sizes of the initial materials, the mixing ratios and the compression process are the subject of the invention and of the examples given.

11427 Carbonization of aromatic hydrocarbons. V. Microscopic features of carbons obtained by the aid of catalysts. Mochida, I. (Kyushu Univ., Fukuoka); Nakamura, E.; Maeda, K.; Takeshita, K.; Hoshino, T. *Carbon;* **14**: 341-344(1976).

Microscopic observation of carbons obtained from pure aromatic hydrocarbons by the aid of carbonization catalysts was carried out to clarify the microstructure of these carbons of different features. Reflected polarized-light microscopy distinguished needle, mosaic and isotropic cokes, former two of which were produced with aluminum chloride and the last with potassium. High resolution microscopy revealed that these carbons calcined at 1250° had different degree of layered structure, corresponding to the crystallographic parameters of these samples graphitized at 2500°C. The reasons for the carbons produced with potassium to be non-graphitizable are discussed from the macro- and micro-features of the carbons.

11428 Making foundry coke from blends containing poorly caking coals. Timofeev, Yu.D. (Moscow Coke and Chemical Works); Zhitov, B.N.; Makarov, G.N.; Blozhko, N.K.; Narkevich, E.A.; Lipking, A.G. *Coke Chem., USSR (Engl. Transl.);* No. 4, 16-18(1976).

Translated from Koks Khim.; No. 4, 14-16(1976).

Conditions are specified for making foundry coke from thermally prepared charge with a high content of group 2SS coals from the "50th October Anniversary" open-cast working. The quality indices of the coke are quoted, together with the results of cupola melting trials.

11429 Ring oven for making special types of coke. Gaevskii, P.F.; Pavlov, V.V.; Timofeev, Yu.D. (Moscow Coke and Chemical Works). *Coke Chem., USSR (Engl. Transl.);* No. 4, 19-22(1976). Translated from Koks Khim.; No. 4, 16-19(1976).

A description is given of the pilot-commercial ring oven set up in the Moscow Coke and Chemical Works for development work on the continuous production of special types of coke. Coal carbonization in ring ovens by the MKhTI method is one of the promising ideas developed in connection with the development of continuous production techniques for various types of coal. Compared with the conventional coke-oven, the ring oven offers numerous advantages. It is possible to regulate the time-temperature conditions under which the charge is carbonized and the vapours and gases are pyrolyzed, so that they can be optimized with respect to both the quality of the coke and the compositions of the coke-oven gas and coal tar. The process is continuous and it is feasible to automate virtually every operation, notably the labor-intensive operations of charging, pushing, and coke quenching. Coke can be made from individual poorly or non-caking coals. The ring-oven process is particularly effective for making the special types of coke so badly needed by the national economy for ore sintering, ferroalloy production, etc.

11430 Use of dense silica brick and its effects on temperature distribution in pitch-coke ovens. Kaloc, M.; Rzhiman, A. *Coke Chem., USSR (Engl. Transl.);* No. 4, 23-26(1976). Translated from Koks Khim.; No. 4, 20-22(1976).

Temperature distributions have been measured and calculated in the wall of pitch-coke ovens built of dense silica brick, with reference to the effects of the wall thickness and thermo-physical brick properties on performance. A calculating program and procedure have been developed for investigating the effects of these variables on such process parameters as the carbonizing period and rate, etc. Pitch-coke outputs have recently been increasing rapidly. In order to increase the battery capacity and minimize heating-gas consumption, it is necessary to modify the basic oven dimensions, and the scope for this depends on the quality of the refractories available for use. New possibilities are opened up by the recent development of dense silica brick, which combines increased thermal conductivity with superior corrosion and erosion resistance. By using this material for pitch-coke ovens, one can prolong their life and economize on high-grade silica refractories. Before such material is used for pitch-coke ovens, one must investigate the temperature distribution in the brickwork and determine the maximum cooling effect to be expected on contact with relatively cold incoming pitch. Thermal calculations of the cooling conditions are essential when designing pitch-coke ovens in high-quality materials.

11431 Removing nitric oxide from coke-oven gas. Kaplina, E.G. (Moscow Coke and Chemical Works); Shevchuk, V.L.; Belova, O.I. *Coke Chem., USSR (Engl. Transl.);* No. 4, 30-33(1976). Translated from Koks Khim.; No. 4, 25-27(1976).

When coke-oven gas containing nitric oxide is subjected to low-temperature separation, it is liable to deposit nitro-resins in the separation apparatus, which can lead to spontaneous explosion. Periodic shutdowns are necessary to remove the nitro-resins; the period of continuous operation is inversely related to the NO content of the incoming coke-oven gas. The latest separation units installed in the Soviet Union have a very large throughput (32,000 m^3/h of coke-oven gas). Such units have been installed in the synthetic ammonia plant at the Moscow Coke and Chemical Works. If they are to be operated continuously for 12 months, the NO content of the incoming coke-oven gas must not exceed 0.025 cm^3/m^3 (ppM). If a lower level can be maintained the apparatus can remain on stream that much longer and its output will increase accordingly. The coke-oven gas supplied for ammonia synthesis from batteries using injection must not contain more than 6 ppM, according to GOST 8330-74. At the Moscow plant, it usually contains 4 to 6 ppM and it must obviously be purified thoroughly before entering the separation apparatus. The provisions made for removing NO from the coke-oven gas are not efficient enough and a study has been made of every link in the production chain with reference to their effects on the NO content of the gas.

11432 Ammonia—oxygen production in the carbonization industry. Kutovoi, A.P. (Moscow Coke and Chemical Works). *Coke Chem., USSR (Engl. Transl.);* No. 4, 36-37(1976). Translated from Koks Khim; No. 4, 29-30(1976).

The synthetic ammonia plant at the Moscow Coke and Chemical Works was commissioned in 1963 and the oxygen plant in 1965. The two plants were needed to meet the demand for liquid nitrogenous fertilizers from the agricultural areas around Moscow, particularly the vegetable farms, and the demand for air-separation products from industrial undertakings in and around Moscow. Ammonia production takes place in several stages. The coal gas is purified in several stages and a nitrogen-hydrogen mixture is metered into the separation apparatus in proportions corresponding to the stoichiometric NH_3 composition (75% H_2 and 25% N_2 by volume), and the ammonia is synthesized at 320 atm pressure and 560°C. All the plant by-products are utilized. The rich gas and ethylene fraction are used for coke-oven heating. The ammonia in the tank gases are returned to the recovery plant for ammonium sulfate production or used to make ammonia solution. The expander gases from the ammonia-liquor regeneration unit are used to make technical CO_2. The air separators in the oxygen plant operate under high pressure to make oxygen, nitrogen and argon. Organization and technical improvements have enabled the ammonia plant to keep pace with increasing supplies of coke-oven gas and increase output to more than 8000 tons/year above the nominal ammonia output.

11433 Technical and equipment innovations in a carbonization plant. Mironov, M.A. (Moscow Coke and Chemical Works). *Coke Chem., USSR (Engl. Transl.);* No. 4, 46-48(1976). Translated from Koks Khim.; No. 4, 37-39(1976).

Since commissioning the plant 25 years ago, much has been done to improve production techniques, replace obsolete equipment and keep the plant up to date. In the coal-cleaning plant, the original blending tables have been replaced by type DN 6/3A units with repeating recorders in the control office so that blending operations are continuously monitored. By centralizing the controls, every conveyor and item of equipment in the coal-preparation, coke-grading and power-station supply systems have been brought under control from a single point. Automatic charge distribution in the silo has made silo-top duties redundant. Smokeless charging is one of the most important innovations in the coke-oven plant. The original equipment was developed and installed back in 1956 by the plant labor force and staff. It was modernized in 1971 when hydraulically operated ascension pipes were fitted.

11434 Using a nozzle-type regenerator in a carbonization plant. Kruglova, M.I.; Kostyukova, L.N.; Kovalenko, V.S.; Deev, V.Ya.; Tatarenkov, V.A. *Coke Chem., USSR (Engl. Transl.);* No. 4, 51-52(1976). Translated from Koks Khim.; No. 4, 41-43(1976).

Descriptions are given of the existing scheme for wash-oil regeneration in which it is not preheated, and an alternative scheme in which it is preheated and a hollow nozzle-type regenerator is used.

11435 Axial shear relay for the rotors in coke oven-gas-blowers. Gulyaev, V.G. *Coke Chem., USSR (Engl. Transl.);* No. 4, 53(1976). Translated from Koks Khim.; No. 4, 43-44(1976).

An account is given of the construction, installation and adjustment of axial rotor shear relays in coke-oven-gas blowers.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 11569

11436 XPS study of the oxidation of pyrite and pyrites in coal. Frost, D.C.; Leeder, W.R.; Tapping, R.L.; Wallbank, B. (Univ of BC, Vancouver). *Fuel;* **56**: No. 3, 277-280(Jul 1977).

X-ray Photoelectron Spectroscopy (XPS) was used to study mineral, synthetic and coal-associated pyrites, oxidized for various time intervals at low temperatures with humid air or oxygen. This was done to find out if XPS could detect, monitor and clarify pyrite surface-oxidative changes that influence surface-dependent coal-cleaning methods such as froth flotation, and could provide a means of directly analyzing coal sulfur, by determining if oxidizing conditions existed. The results indicate by this method one might determine directly the organic sulfur in coal. 28 refs.

HYDROGENATION

REFER ALSO TO CITATION(S) 11458

11437 Chemical structure of asphaltene separated from hydrogenated Hokkaido coals. Yoshida, R.; Maekawa, Y.; Takeya, G. *Nenryo Kyokai-shi;* **53**: No. 572, 1011-1020(1974). (In Japanese).

Five types of coal (Soya, Haboro, Taiheiyo, Horonai, and Oyubari) were hydrogenated at 400°C and an initial hydrogen pressure of 100 kg/sq cm for 6 to 114 min in the presence of iron oxide and sulfur catalyst with anthracene oil as solvent. Taiheiyo and Oyubari coals also were hydrogenated at the same conditions without any solvent, and asphalts produced from these coals were hydrogenated separately. Determinations made included elementary composition, hydroxyl group concentrations, IR and nuclear magnetic resonance spectra, molecular weight, and gas-phase chromatograms. Yields of asphaltene increased with the carbon content of the original coal in the range of 20 to 50%. Elementary compositions were analogous, while the aromatic ring structure seemed similar to

that of the original coal. Differences of chemical structure between oils produced from coal or from asphalt are explained by a formation mechanism.

11438 Coal particle integrity in high-temperature solvents, with and without agitation. Plett, E.G.; Alkidas, A.C.; Rogers, F.E.; Summerfield, M. (Princeton Univ, NJ). *Fuel;* **56**: No. 3, 241-244(Jul 1977).

The physical characteristics of W. Kentucky (bituminous) and Wyodak (subbituminous) coal particles after exposure to hydrogen-donor solvents at temperatures of 400-450°C have been observed. Experiments have demonstrated that the agitation rate, initial particle size and solvent-to-coal ratio employed affect not only the rate of coal dissolution, but also the overall yield. 6 refs.

11439 Method for hydrogenating oils derived from coal. Wolk, R.H.; Chervenak, M.C.; Alpert, S.B. (to Hydrocarbon Research, Inc., New York (USA)). German(FRG) Patent 2,436,476/B/. 17 Feb 1977. 6p. (In German).

A process described in which aromatic high boiling point oils obtained from coal are hydrated. More than 60% of a fraction boiling above 525°C (more than 50%) is converted to a fraction boiling below 525°C. The oil is heated and taken through a reaction zone, which has a partial hydrogen pressure between 141 and 246 kg/sq cm and a temperature between 400° and 510°C. The catalyst used in hydration consists of cobalt molybdate on alumina or nickel molybdate on alumina. Characteristics of the coal extract, the properties of the catalyst (chemical analysis, volume, grain size) and the conditions of work for the reaction vessels are communicated.

GASIFICATION

REFER ALSO TO CITATION(S) 11488, 11582, 11807, 11809, 12094, 12308, 12884, 12916

11440 (FE—1521-23) Design report. Volume 4. Section 200. Water wash, sour water stripping, and slurry processing. Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, Phase II. (Foster Wheeler Energy Corp., Livingston, N.J. (USA)). Oct 1977. Contract EX-76-C-01-1521. 96p. Dep. NTIS, PC A05/MF A01.

Section 200 of the coal gasification plant consists basically of water wash, sour water stripping, and slurry processing components. The water wash section contains a Gas Scrubber (S-202), a Water Wash Tower (T-201), a Water Wash Intercooler (E-214), and associated pumps. The sour water stripping section consists of Sour Water Strippers (T-202 and T-203) and associated pumps, exchangers, and drums. The slurry processing section consists of the Slurry Filtration Package (A-202) and associated Flash Strippers (T-204 and T-205), Vacuum System (A-203), and auxiliaries.

11441 (FE—1521-26) Design report. Volume 7. Section 500: gas compression, transport gas, and fuel supply. (Foster Wheeler Energy Corp., Livingston, N.J. (USA)). [nd]. Contract EX-76-C-01-1521. 72p. Dep. NTIS, PC A04/MF A01.

Detailed specification for components of an advanced Coal Gasification System is provided (Gas Compressors, filters, cranes, air heaters, etc.). (LTN)

11442 (ORNL/TM—6066) Coal Technology Program progress report for August 1977. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 65p. Dep. NTIS, PC A04/MF A01.

The projects reported this month include those for coal conversion process development, materials engineering, alkali metal vapor topping cycles, a coal equipment test facility, a fluidized bed combustor technology test unit, engineering and support studies, process and program assistance, and environmental assessment studies. In hydrocarbonization research, material balance results from Run HC-21 confirm earlier tests with Wyodak coal, showing an oil yield of 21% based on MAF coal. In the coal-solvent-hydrogen mixing work, experiments were completed with the Kenics mixer reactor and with the packed-bed reactor. The fracture toughness characterization of 25.4-cm-thick ASTM A543 Class 1 plate is in progress. In the gas-fired potassium boiler project, we completed and leak-tested all of the potassium piping for the system and made preparations for loading the drain tank with potassium. The design work on the fluidized-bed, alkali-metal-vapor cycle system has been completed. In the engineering studies and evaluations project, work was continued on process modeling, the preparation of a Synthetic Fuels Research Digest, a survey of industrial coal conversion equipment capabilities, and studies of flash hydropyrolysis, hot gas purification processes, processes for heat recovery, and hydrogen production by the steam/molten iron process. In the process and program analysis studies, studies were continued on low-Btu gasification, direct combustion, advanced power conversion systems, liquefaction, high-Btu gasification, in situ gasification, and coal beneficiation. The Environmental Monitoring Handbook is being used extensively by contractors and their environmental subcontractors in designing monitoring programs for the nation's first fossil demonstration plants.

11443 Electrolinking method for improving permeability of hydrocarbon formation. Cloud, W.B. (to Mobil Oil Corp.). US Patent 4,046,194. 6 Sep 1977. Filed date 3 May 1976. 6p.

A method of improving the permeability of a hydrocarbon bearing formation such as a coal seam by electrolinking a first well and a second well which have been drilled into the formation is described. Both wells are completed with similar strings of casing. The portion of the casing string which passes into or through the formation is comprised of alternating sections of electrically conductive and nonconductive material. An electrode is lowered into each well into contact with one of the electrically conductive sections. Current is then flowed between the electrodes in the wells until a permeable path through the formation is established. Then one or both electrodes are moved into contact with different conductive sections within the respective wells and the procedure is repeated.

11444 H_2 or CH_4. Future processes for the production of SNG. Stroud, H.J.F. (Br Gas Midland Res Stn, Engl). *Energy Dig. (London);* **6**: No. 3, 4-10(Aug 1977).

This article reviews present and proposed methods of producing substitute natural gas (SNG), consisting mainly of methane, from low-grade fossil fuels. The methods described for oil fractions include catalytic gasification processes, hydroconversion processes, non-catalytic hydrogenation, and steam-oxygen gasification. Gasification processes for coal are then described, both present and proposed, including the use of nuclear heat to improve the thermal efficiency of the process. A still further improvement could be obtained if hydrogen is used as a reactant and not steam, in a reaction sequence of water splitting (decomposing steam to give hydrogen without forming carbon dioxide), followed by hydrogasification (hydrogen combining with carbon to form methane).

11445 Modelling of entrained-bed pulverized coal gasifiers. Ubhayakar, S.K.; Stickler, D.B.; Gannon, R.E. (Avco Everett Res Lab, Inc, Mass). *Fuel;* **56**: No. 3, 281-291(Jul 1977).

An analytical model is formulated to describe the physical and chemical processes occurring in an entrained-bed pulverized coal gasifier. The important processes considered are: mixing of the cold coal-carrier-gas stream with the hot entraining gases, heat transport to the coal particles, the devolatilization of the coal particles to char and volatiles, the gas-phase reaction of these volatiles with the entraining gases and the thermal cracking of the volatiles outside the particles. The solutions to the formulations are presented in the form of local properties as functions of particle residence time and inlet conditions. 28 refs.

11446 Mathematical model for gasification and combustion of coal under pressure. Schlich, E.; Koehne, H. (Technische Hochschule Aachen (Germany, F.R.). Lehrgebiet Energie- und Stofftransport). *Chem.-Ing.-Tech.;* **49**: No. 6, 501(Jun 1977). (In German).

11447 Comparative consideration of brown coal utilization. Speich, P. (Rheinische Braunkohlenwerke A.G., Koeln (Germany, F.R.)). *VIK (Ver. Ind. Kraftwirtsch.) Mitt.;* No. 3, 33-37(Jun 1977). (In German).

From Internationale Kohleforschungskonferenz des ICCR; Sydney, Australia (Oct 1976).

The author deals with the processing of brown coal to synthetic natural gas, synthesis gas, methanol and power fuel with regard to investment and production costs efficiency and losses. The author concludes that brown coal will be ousted by nuclear energy for power generation in the base load region on a long-term basis. Synthesis gas and SNG will be competitive on the market. Except for the production of methanol the production of liquid products is not considered to be profitable yet.

11448 New developments in conventional gasification of brown coal. Franke, F.H.; Pattas, E.; Kloecker, K.J. (Rhein Braunkohlenwerke, Cologne, Ger). *Verfahrenstechnik (Mainz);* **11**: No. 5, 288, 290, 292, 294(May 1977). (In German).

Concepts of integrated and non-integrated plants of tube furnaces and high-temperature Winkler gas generators are discussed. Utilization of optimized equipment components and gasification plant setups is analyzed.

11449 System for ultrasonic monitoring of pipe-wall thinning in coal gasifiers. Stanton, G.C.; Ellingson, W.A. (Energy Research and Development Administration, Washington, DC). *Mater. Eval.;* **35**: No. 4, 46-51(Apr 1977).

High Btu coal-gasification processes currently under development at five pilot plants use pipes to transport crushed coal slurries to the reactors and to transfer product gases from the reactor to additional processing points. Operating temperatures often exceed 1000°F and pressures exceed 64 atmospheres. Crushed coal slurries

with flow velocities of 20 to 80 ft/sec have the potential for causing abrasive wear. This is enhanced by the gas chemistry which increases the potential for severe chemical corrosion. Methods of ultrasonically monitoring pipe-wall thinning were investigated at Argonne National Laboratory. One method utilizes a convectively cooled waveguide to reduce operational temperatures to a level compatible with the operating temperatures of off-the-shelf transducers. It has been demonstrated that the waveguides can be either fusion welded by a technique which does not adversely affect the metallurgical or structural integrity of transfer-line materials, or brazed across 100 percent of their cross-sectional area and produce acceptable acoustic properties for ultrasonic thickness measurements.

11450 Device for gasifying coal under pressure, especially fines in a generator. Pasternak, R.; Bauer, J. (to Steinkohlen-Elektrizitaet A.G. (STEAG), Essen (Germany, F.R.)). German(FRG) Patent 2,540,166/A/. 17 Mar 1977. 9p. (In German).

A briquetting installation on the stack serves for the continuous stack charging with coal, particularly with fines, of a generator for coal gasification under pressure. The coal to be gasified and/or the briquetting installation form the generator seal for the maintenance of pressure in the generator. The briquetting installation contains at least one rolling press, arranged above the stack. The briquetting press has an exhauster for occuring gas leakages and is charged by a worm conveyor.

11451 Device for gasifying coal, especially fine coal in a generator. Kaimann, W.; Pasternak, R.; Bauer, J. (to Steinkohlen-Elektrizitaet A.G. (STEAG), Essen (Germany, F.R.)). German(FRG) Patent 2,540,151/A/. 17 Mar 1977. 11p. (In German).

In order to make the undersize of 0-2 mm rejected until now, usable for coal gasification in a fixed-bed reactor and to change the discontinuous feed of the coal to be gasified into continuous feed, the following method is proposed: On the stack, a device for agglomerating the coal to be gasified is placed, having a continuously operating feed and discharging green agglomerates into the stack. The chaser mill fed by a sciew-type conveyor takes charge of the shaping of this agglomerates. The components placed above the stack are arranged in pressure-tight capsules. The coal to be gasified and/or the agglomerating device form the bottom of the generator.

11452 Simultaneous in-situ gasification of several coal seams. Wenzel, W.; Franke, F.H.; Gudenau, H.W. German(FRG) Patent 2,533,657/A/. 17 Feb 1977. 5p. (In German).

The invention refers to in-situ gasification of coal in the case of coal seams which are several meters apart from each other, while the coal-free interim layers are much thicker than the seams. The entire gasification medium (oxidating and hydrating) is fed via a borehole into one seam only while the others are either not blanketed jet or sealed off against the gasification medium in order to avoid slow simultaneous gasification (heating up of the rock). After having got down the coal of the seam first dealt with, other seams follow suit. The seams are gasified one after the other from top to bottom or vice versa, the latter case demanding the empty seams to be filled with water.

11453 Coal gasification development stymied. Hale, D. *Pipeline Gas J.;* **203**: No. 3, 22-24(Mar 1976).

A survey of 22 commercial U.S. coal gasification projects tabulate them by company, giving site, process, capacity (gas output), coal feed (type and rate), latest estimated cost, and current status. Delays occasioned by need for Federal Power Commission approval, for Environmental Impact Statement final approval, and for approvals from other agencies enable inflation to bring dramatic cost increases. Western Gasification Co. has the coal and water supply for four 250 million cu ft/day plants to supply gas needed in California and the adjoining area; when the first plant application was filed 2/17/73, a $447 million plant would produce SNG for $1.32/thousand cu ft, but today, if construction began immediately, it would be late 1979 to early 1980 before the plant could go into operation, and the cost would be over $1 billion for a gas cost of about $3.00/thousand cu ft.

11454 Compensation effect in the steam gasification of coal. Feistel, P.P. (Bergbau-Forschung GmbH, Essen); Van Heek, K.H.; Juntgen, H.; Pulsifer, A.H. *Carbon;* **14**: 363-364(1976).

The results of an investigation at Bergbau-Forschung on the steam gasification of coal at pressures from 10 to 70 bar and in the temperature range from 400 to 1100°C have been reported previously. The effect of temperature on the reaction rate was determined for several coals and chars using a non-isothermal technique with a constant heating rate of 10°C/min. At Iowa State University, the activation energy and frequency factor were determined for a given coal char with and without a catalyst present. The measurements were made in an isothermal, fixed bed reactor. In both investigations, a model that assumes that the reaction rate depends only on the amount of carbon in the reactor was used to interpret the results, $-dc/dt = kc$ where c is the fraction of carbon remaining in the reactor at time t. The materials investigated are listed. They differ from each other not only in rank, as indicated by the volatile matter content, but also by the quantity and composition of the ash associated with each sample. In the case of the Bear coal char, runs were made with and without the addition to the char of 10 wt% potassium carbonate. The frequency factors and activation energies varied from 6×10^3 to 1.4×10^{10} min^{-1} and from 24.6 to 60.7 kcal/mole, respectively, and exhibited a marked compensation effect. Either changes in pressure or coal type, or the addition of the catalyst seemed to cause log A and E to vary in a linear manner. The similarity between the effect of potassium carbonate addition and the use of the different coals seems to suggest that the differences in reactivity between the various coals are due to the catalytic nature of the coal ash.

11455 Gasification of coal for use as a natural gas substitute. Sobolewski, L.; Ihnatowicz, M. (Glowny Instytut Gornictwa, Katowice, Poland). *Przem. Chem.;* **55**: No. 1, 4-8(1976). (In Polish).

A discussion covers coal gasification based on the use of steam and oxygen, or oxygen, and various heat sources; hydrogasification; and gasification methods including Lurgi, Koppers, Bigas (Bituminous Coal Research Inc.), Synthane (U.S. Bureau of Mines), Atgas (Applied Technology Corp.), and Hygas (Institute of Gas Technology).

11456 Coal gasification to obtain a natural gas substitute (conclusion). Sobolewski, L.; Ihnatowicz, M. (Glowny Instytut Gornictwa, Katowivce, Poland). *Przem. Chem.;* **55**: No. 2, 65-70(1976). (In Polish).

A review with 37 references covers methods of coal gasification without oxygen, such as Hygas, Acceptor, Kellogg, Union Carbide/Battelle, and Hydrane hydrogasification of coal.

11457 Coal and fuel oil as a substitute for natural gas in nitrogen industry. Czerkawski, A. *Przem. Chem.;* **54**: No. 12, vp(1975). (In Polish).

A review with 17 references covers methods used for manufacturing synthesis gas for ammonia production from high-boiling petroleum fractions and from bituminous and brown coal or coke.

11458 Coal technology. Jaszay, T. *Energ. Atomtech.;* **28**: No. 11-12, 539-545(1975). (In Hungarian).

A discussion covers recent developments in the technology of coal gasification and hydrogenation.

LIQUEFACTION

REFER ALSO TO CITATION(S) 11442, 11467, 11473, 11488, 11582, 11693, 12542

11459 Effect oof hydrogen-donor solvent on the liquefaction of coal. *Nenryo Kyokai-shi;* **56**: No. 5, 319-328(May 1977). (In Japanese).

Fundamental reactions in the solvent extraction of coal can be classified into the thermal decomposition of coal and the subsequent hydrogenation of formed fragments by hydrogen-donor solvent. The following items were reviewed from the theoretical point of view: (1) Elemental reactions of coal liquefaction in the presence of hydrogen-donor solvent; (2) solvent effect on the homolytic decomposition reaction; (3) role of hydrogen-donor solvent in coal liquefaction; (4) effect of molecular hydrogen on coal liquefaction; and acceleration effect of phenolic compounds on coal liquefaction. 36 refs.

11460 Method for the alluvial filtration of liquefied coal. Mueller, H.; Hirsbrunner. R.; Mueller, F. (to Chemap A.G., Zurich (Switzerland)). German(FRG) Patent 2,625,690/A/. 13 Jan 1977. 7p. (In German).

A process of alluvial filtration is described for the economic separation of solids from liquefied coal, in which a part of the filter solids are dried by gas and filtering accessory located in it are regained and re-used. Inorganic salts and magnetic material are given as filter accessories. The separation of the filter accessory material from the filter solids is to be carried out in sieving equipment, air separators, by extraction or by magnetic separation.

11461 Process for the treatment of coal and treated coal produced by the process. Horowitz, C.; Dichter, M. (to PolyGulf Associates, New York (USA)). German(FRG) Patent 2,628,718/A/. 13 Jan 1977. 16p. (In German).

The invention concerns improved methods of working for the fluidization of coal, particularly concerning a process of modifying coal by forming a new coal product, which is more easily liquefiable than coal in its natural condition. This modified coal product is characterised by the fact that it has grafted polymer side-chains. It is the reaction product of coal carbon radicals which were formed from natural coal in the presence of a catalyst system in the form of a free radical or ion catalyst, and a polymerisable monomer. The examples given explain the invention.

11462 Mathematical description of the process for hydrocracking of distillates of liquid-phase coal hydrogenate. Gagarin, S.G.; Zamanova, L.P. *Khim. Tverd. Topl.;* No. 1, 94-99(1976). (In Russian).

A mathematical-statistical method in the form of a system of polynomial equations was developed for predicting the maximum yield of gasoline, considering technological limitations. The effects of experimental conditions on yield of C/sub 6-10/ aromatic hydrocarbons and on gas compositions were also considered.

11463 Synopses/hydroliquefaction of high-moisture-content lignite under hydrogen or carbon monoxide. Oelert, H.H.; Siekmann, R.; Islam, K.U. (Technische Univ., Hanover). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **28**: No. 6, 290(Jun 1975). (In German).

The typical yields from 1:0 to 1:4 coal-water suspensions in a shake-feed autoclave at 360°C under approximately 100 atm hydrogen increased at higher water concentrations or when phenol/tetralin solubilizer mixtures were added. The viscous-to-solid, low-molecular-weight, sulfur- and oxygen-poor, soluble product retained the feed hydrogen-carbon ratio. Under 50 atm carbon monoxide and at 335° to 380°C, the uncatalyzed, diffusion-controlled reaction of 1:6 coal-water mixtures began in the heat-up period, yields increased with reaction time, and the product molecular weights were higher but decreased above 380°C. The hydrogen-carbon ratio in the products increased by 25% to 1.23:1 at 8% hydrogen content. At high conversions, alkane and condensed aromatics contents fell off, but small substituted aromatics increased (e.g., 0.41 aromaticity and 11% methyl carbon content).

11464 Coal liquefaction technology in Manchuria. Morikawa, K. *Sekiyu Gakkaishi;* **18**: No. 5, 377-382(May 1975). (In Japanese).

A survey covers the history, technology, and production figures of the catalytic coal liquefaction process developed by the Japanese in Manchuria in the 1930's and 1940's.

11465 Hydroisomerization of n-paraffins of distillates of coal liquid-phase hydrogenation product. Krichko, A.A.; Yulin, M.K. (Inst. of Mineral Fuels, Moscow). *Khim. Tverd. Topl.;* No. 3, 91-93(1975). (In Russian).

Two prehydrofined 180° to 320°C fractions, obtained by distilling hydrogenated products of 40:60 coal-petroleum mixtures of different origin, were hydroisomerized over a supported palladium catalyst in a 170 cc reactor at optimum conditions of 420°C, 40 atm, hourly space velocity of 0.5, and 1500 l hydrogen/l feed. Normal paraffins decreased from 11.0 to 11.3% to 1.5 to 2.2%, and aromatics increased from 27.7 to 28.8% to 33.8 to 34.8%. The product was almost free from unsaturates and sulfur and nitrogen compounds, had a low crystallization temperature (-5.8° to 60°C), and could be used as a component of gasoline or diesel fuel.

11466 Conversion of coals to oils and chemicals. Murthy, V.A.K. *J. Mines, Met. Fuels;* **23**: No. 6, 286-292(1975).

Conversion of coals to oils and chemicals is reviewed with seven references covering hydrogenation, solvent extraction, and Fischer—Tropsch processes.

SOLVENT EXTRACTION

11467 Evidence for the involvement of quinone rings in reactions of some coals with tetralin. Brower, K.R. (NM Inst of Min and Technol, Socorro). *Fuel;* **56**: No. 3, 245-248(Jul 1977).

Model compounds representing a variety of hydrocarbon groups and most of the oxygen-containing functional groups have been tested for reactivity with tetralin at 400°C. Only the quinones were capable of oxidizing tetralin to naphthalene. Anthraquinone is completely deoxygenated to anthracene. Evidence for homolysis of carbon-carbon bonds was found only in the case of dibenzyl. It is suggested that oxidized coals near the surface contain quinone rings, and that dissolution by tetralin is primarily then due to lowering of the solvent parameter as a consequence of deoxygenation. 13 refs.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 11431, 11432, 11434

11468 Method for isolating the solid phase from coal tar. Mishin, I.F. *Koks Khim.;* No. 9, 47-48(1975). (In Russian).

A method is based on the assumption that the solid phase contains >80% of particles under 40μ and the content of the fraction above 2 mm is <2 to 5%. Coal tar is filtered on sieves into fractions >200, >40, and <40μ. Solid phases of the fractions are separated after their extraction with toluene, benzene, etc. on filter paper in vacuo. Solid phase is dried at 120°C and weighed. Solid phases are further fractionated on the sieves to fractions 3.0; 2.0; 1.0; 0.5; 0.3; 0.2 and 0.14; 0.10; 0.08; 0.06; 0.05 and 0.04 mm.

11469 Use of a plate-packed scrubber to recover benzol hydrocarbons. Timofeev, Yu.D. (Moscow Coke and Chemical Works); Pavlov, V.V.; Moskvitin, K.S.; Borisov, G.S.; Dytnerskii, Yu.I. *Coke Chem., USSR (Engl. Transl.);* No. 4, 27-29(1976).

Translated from Koks Khim.; No. 4, 22-24(1976).

Test data on an experimental plate-packed scrubber for benzol hydrocarbons recovery were used to determine the number of plates required in a commercial scrubber. Trials with a converted scrubber have shown that plate packing is quite efficient and its resistance is much lower than that of the normal packing.

11470 Saleable CO_2 production from ammonia-plant waste gases. Gaevskii, V.A.; Belova, O.I. (Moscow Coke and Chemical Works). *Coke Chem., USSR (Engl. Transl.);* No. 4, 38-39(1976).

Translated from Koks Khim.; No. 4, 31-32(1976).

Before synthetic ammonia can be made from separated coke-oven gas, the latter is purified with ammonia solution at 40 g/l concentration to remove CO_2 and H_2S. At the liquor regeneration stage, the ammonium carbonate solution evolves 1000 m^3/h of waste gas, which was at one time discharged to atmosphere. However, this was a serious source of atmospheric pollution, since the gas consisted (in % by volume) of 99.0 to 99.5 CO_2, 0.5 to 1.0 inert impurities (O_2, N_2, CH_4) and various toxic impurities, notably (in mg/m^3) 100 H_2S, 400 HCN, 400 benzene and 1 to 2 NH_3. The biggest difficulty in producing saleable CO_2 from this gas was how to remove the impurities. Complete removal of organic matter and HCN was achieved by investigating and developing a catalytic combustion process. Chromatographic analyses on the organic impurities after concentration by absorption showed that apart from benzene itself the gas also contained its homologues (toluene, xylene), sulfur compounds (carbon disulfide, thiophen), unsaturated compounds (cyclopentadiene, styrene) and naphthalene. The amounts of each constituent, notably benzene and toluene, depended on the recovery rates at the respective stages in coke-oven-gas purification and could vary widely. Benzene accounted for 40 to 90% of the total of organic impurities between 200 and 1500 mg/m^3. Benzene is the most difficult of the compounds to oxidize, and if the residual concentration after combustion is insignificant it can be assumed that all other organic impurities have been destroyed. The benzene contents of the gas before and after purification were determined chemically by nitrating the benzene to dinitrobenzene.

PROPERTIES

REFER ALSO TO CITATION(S) 11419, 11420, 11422, 11423, 11427, 11548, 12880

11471 Structural analysis of coal by NMR. Maekawa, Y. (Japan Government Industrial Development Lab., Hokkaido). *Sekiyu Gakkaishi;* **18**: No. 9, 746-752(Sep 1975). (In Japanese).

A review of NMR methods applicable to coal analysis is given.

11472 Examination of some trace elements in South Wales coals. Chatterjee, P.K.; Pooley, F.D. *Australas. Inst. Min. Metall. Proc.;* No. 263, 19-30(Sep 1977).

The coal measures of the South Wales coalfield contain at least 50 horizons at which coal seams are known to occur. More than 300 samples of coal were collected from these coal measures and this paper outlines the findings of an investigation of the pattern and distribution of 12 trace elements in South Wales coals. A comparison of trace element contents of the South Wales coals is made with trace element values found elsewhere and an attempt was made to establish the organic affinity of the elements in different seams and in the coalfield as a whole. An important function of such an analysis is to determine the order of abundance of trace elements and this was performed for individual seams and for the whole coalfield. The interrelationship of certain elements in some seams is also examined with a view to understanding the effectiveness of such an approach to seam correlation. Ranges of values are quoted together with the mean values of the various elements. Variations of elemental values within a seam section and over the coalfield as a whole are discussed.

11473 Biological markers in coal and coal liquefaction products. White, C.M.; Shultz, J.L.; Sharkey, A.G. Jr. (Energy Research and Development Administration, Pittsburgh). *Nature (London);* **268**: No. 5621, 620-622(18 Aug 1977).

Recent work by others on the wave spectrometry of paraffins isolated from a bituminous coal indicated a predominance of odd over even carbon numbered n-paraffins. The authors separated a saturate fraction from a heavy oil produced from coal by the Synthoil process and further separated it into two fractions using molecular sieves. When they examined these by gas chromatography and mass spectrometry, they found no evidence of odd carbon numbered n-paraffins predominating over even. Nor did they find evidence of this in extracts of the feed coal. It is speculated (on the basis of other results), that such a condition may exist with some coals and not others and may be related to the rank of the coal.

Optical activity is discussed briefly. The behavior of some very stable organic compounds in the diagnosis of the coal is discussed. (LTN)

11474 Coal rank and coke reactivity. Beesting, M.; Hartwell, R.R.; Wilkinson, H.C. (Br Carbon Res Assoc, Chesterfield, Engl). *Fuel;* **56**: No. 3, 319-324(Jul 1977).

The object of this work was to investigate relations between the combustion properties of cokes and the properties of the coals from which they were prepared. To this end, cokes were prepared under standard conditions of carbonization from coals varying in rank from 18 to 39% of volatile matter (dmmf). These cokes were reacted with oxidizing gases under controlled conditions of temperature and gas composition and changes in structure, strength and density of the cokes due to loss of carbon were followed by various experimenal techniques. The influence of the ash composition of the cokes on their combustion properties was also examined. 8 refs.

11475 Carbon-13 magnetic resonance of coal-derived liquids. Pugmire, R.J.; Grant, D.M.; Zilm, K.W.; Anderson, L.L.; Oblad, A.G.; Wood, R.E. (Univ of Utah, Salt Lake City). *Fuel;* **56**: No. 3, 295-301(Jul 1977).

Carbon-13 Nuclear Magnetic Resonance Spectroscopy has been applied to coal-derived liquids in order to obtain additional information regarding molecular structure and composition. The data have demonstrated that, although the chemical structure is extremely complex, a significant amount of material is present in the form of normal paraffinic material both as free paraffins and alkyl substitutents on aromatic and hydroaromatic materials. Semiquantitative estimates are made of the alkyl content of the liquids. 25 refs.

11476 Apparent catalysis of graphitization--3. Effect of boron. Murty, H.N.; Biederman, D.L.; Heintz, E.A. (Airco Speer Carbon-Graphite, Niagara Falls, NY). *Fuel;* **56**: No. 3, 305-312(Jul 1977).

The catalytic effect of boron on the graphitization behavior of three diverse industrial carbons has been studied. It is found that the rate of graphitization increases with increasing boron concentration in the ranges of catalyst employed. The activation energy for boron-catalyzed graphitization is found to be 963 kJ/mol which is the same as the value obtained for the graphitization of boron-free carbons. 33 refs.

11477 Micropore structure analysis of coal from adsorption isotherms of methanol. Spitzer, Z.; Biba, V.; Bohac, F.; Malkova, E. (Fuel Res Inst, Prague, Czech). *Fuel;* **56**: No. 3, 313-318(Jul 1977).

Results are presented of a study of the distribution of pore volume and surface in micropores of coal from adsorption equilibria of methanol vapors at temperatures ranging between 293 and 343 K. Typical parameters of the micropore structure of twenty samples of coals of carbon contents between 64 and 91% are calculated for a model of cylindrical pores. 16 refs.

11478 Quantitative analyses of pyrite in coal by optical image techniques. Harris, L.A.; Rose, T.; DeRoos, L.; Greene, J. (Oak Ridge National Lab., TN). *Econ. Geol.;* **72**: No. 4, 695-697(1977).

It has been demonstrated that quantitative analyses of pyrite in coal can be achieved by means of optical image analysis techniques. However, it is necessary to measure the total sample surface since selected area analyses may lead to erroneous values. The roots of this problem stem from the nonuniform distribution of pyrite throughout a coal briquet. In addition, the inability of optical systems to resolve pyrite grains in the submicron range is a further source of errors.

11479 Elastic properties of two coals. Ho, H.Y.; Gerstle, K.H. (Univ. of Colorado, Boulder). *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **13**: No. 3, 81-90(Mar 1976).

Measurements of the elastic properties of coal were made on cubic and cylindrical specimens in order to provide the matrix of properties necessary for the application of the finite element method to the calculation of the stability and deformation of mine openings. It is concluded that coal should be considered an orthotropic material with anisotropy residing mainly in the relation between principal normal and shear compliances. The mechanical properties can best be supplied in the form of material stiffness matrices or their inverse (compliance matrices). Data for two different coals and different test methods are compared and possible idealizations are discussed. (LTN)

11480 Hydrogen bonding study of quinoline and coal-derived asphaltene components with o-phenylphenol by proton magnetic resonance. Taylor, S.R.; Galya, L.G.; Brown, B.J.; Li, N.C. (Duquesne Univ., Pittsburgh). *Spectrosc. Lett.;* **9**: No. 11, 733-741(1976).

Proton magnetic resonance (PMR) studies are reported of hydrogen bonding between the OH proton of o-phenylphenol (OPP) and the nitrogen electron donor of quinoline (Qu). Data are also reported on the hydrogen bonding of a coal-derived asphaltene and its acid and base components with OPP. Determination was made of the equilibrium constants of the 1 : 1 complex between OPP and Qu at 39, 32, 1, and -18°C from the PMR studies. Qualitative results are reported for the interaction between the base fraction of asphaltene and OPP at 32, 1, and -26°C.

11481 Bulk density characteristics of binary mixtures of carbon powders. Bhatia, G. (National Physical Lab., New Delhi). *Carbon;* **14**: 311-313(1976).

Characteristic curves of bulk density of binary mixtures of carbon powders are explained on the basis of two competing mechanisms, one contributing to the increase in bulk density on account of finer fractions occupying the inter-particle space of the coarse fraction and the second causing a reduction in bulk density due to mechanical replacement of coarser fraction by finer fraction.

11482 Rheological properties of carbon mixes at very low shear rates using a capillary rheometer. III. Bhatia, G. (National Physical Lab., New Delhi). *Carbon;* **14**: 315-317(1976).

A capillary rheometer has been used to determine the rheological properties of carbon mixes consisting of petroleum coke as filler and coal tar pitch as binder. It is shown that carbon mixes behave as Bingham materials with definite yield stresses. The yield stress was found to be a general property of all carbon mixes and its value is independent of the size of the capillary die. It was also seen that extrusion at low shear rates through big diameter capillaries results in slipflow. The slipflow occurs when the applied stress is somewhat below the yield stress, the material then extrudes without the formation of a core which otherwise would cause cracks in the product after baking. This explains why big diameter rods are generally extruded at very low speeds in usual manufacturing process. The modified Buckingham—Reiner equation has been applied to the case of slipflow and the values of yield stress and plastic viscosity calculated. These values agree well with those obtained from the consistency curve.

11483 Rheological properties of carbon mixes using a capillary rheometer. IV. Bhatia, G. (National Physical Lab., New Delhi). *Carbon;* **14**: 319-321(1976).

The capillary rheometer has been used to determine the rheological properties of various carbon mixes consisting of petroleum coke as filler and coal tar pitch as binder. It has been shown that the carbon mixes containing various proportions of binder behave rheologically as Bingham material with yield stress and plastic viscosity. When binder level exceeds a certain optimum level, plastic viscosity shows a steep fall from 20×10^5 to 2×10^5 P (poises), while yield stress does not show much variation. A comparatively better rheological behavior is observed with capillary rheometer than that with parallel plate viscometer.

11484 Preparation and properties of sputtered glassy carbon films. Marinkovic, Z.; Roy, R. (Pennsylvania State Univ., University Park). *Carbon;* **14**: 329-331(1976).

Some remarkable "glassy" carbon films with densities from 0.5 to 1.79 have been prepared by sputtering from carbon targets. Conditions for the preparation of various carbon films by rf sputtering and data on the density, mechanical properties, microhardness, microstructure and crystal structure of the films formed are presented. Optimum sputtering conditions for obtaining mechanically stable films up to 40μ thick are described. It is shown that density and microhardness of the carbon can be controlled within wide limits, and both increase with decreasing deposition rate. The higher density carbon films adhere poorly to glass, while the low density carbon films on glass are stable. All sputtered carbon films are non-crystalline and have a grainy microstructure. Potential applications exclude corrosion protection but include novel catalyst supports.

11485 Effects of bulk-components on the grindability of coals. Hsieh, S.S. University Park, PA; Pennsylvania State Univ. (1976). 161p. University Microfilms Order No. 76-24,770.

Thesis (Ph. D.).

The grindability of coal is a composite physical property, which varies with the change in rank as well as the change in composition of the coal. Thus, for a different rank of coal, the grindability changes whenever the coal rank changes. For a specific rank of coal, the grindability of the heterogeneous coal also varies as the composition of coal varies, due to the different grinding characteristics of each component of coal. In this work a bulk-components hypothesis was proposed to explain the difference in the grindability of coal. The essence of this hypothesis is that the grindability of a given coal is governed by the combined influence of its rank, petrographic constituents, and mineral matter. Plots of the hypothetical grindability of different macerals indicate that the results were in agreement with the grindability experiments on different maceral-rich coals. The relationship between the grindability tests for different rank of coals and their mineral matter content can also be explained by the hypothetical grindability of the total mineral matter. The incorporation of selective grinding to the equations was unable to reduce the variance of the prediction. The substitution of different minerals for the total mineral matter within the mineral matter volume function also did not improve the results of the computations.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 12982

11486 Process and apparatus for the separation of crude benzol and naphthalene from washing oil. Ullrich, H. (to Dr. C. Otto and Comp. G.m.b.H.). US Patent 4,046,641. 6 Sep 1977. Priority date 19 Mar 1974, German, Federal Republic of (F.R. Germany). 6p.

A process and apparatus for the regeneration of washing oil which has been spent to recover naphthalene and/or benzol from coke oven gas. The spent washing oil is stripped by steam in a bubble column arranged as an integral part of a single main column that includes first, second and third exchange column sections disposed in a superimposed relation one above the other to receive the stripped vapors from the bubble column. The first exchange column section is fed with a mixture of toluene, xylene and naphthalene as a reflux, the second exchange column section is fed with water as the reflux and the third exchange column section is fed with benzol as the reflux. The head product from the column is condensed and passed through a first-phase separator to obtain a substantially anhydrous benzol fraction and a water fraction. These fractions are separately used as a reflux for the second and third exchange column sections. The liquid mixture drawn off from the second exchange column section is separated in a second-phase separator into a water phase and into a substantially anhydrous toluene-xylene-naphthalene phase. The latter is resolved by steam distillation in a secondary column having stripping and rectifying sections for resolving into a toluene-xylene fraction and a naphthalene fraction.

11487 Device for purifying filler gas developed by coking plants and removed by an offtake pipe. Hoelter, H. German(FRG) Patent 2,517,968/A/. 4 Nov 1976. 6p. (In German).

A device for purifying filler gas is presented. It is attached to or on machine wagon and has a kind of telescopic suction pipe. This suction pipe in designed in such a way that the filler gas can be removed via an offtake pipe and/or extraction pipes.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11498, 11499, 11502, 11554, 13067, 13068

11488 (CONF-771135—1) **Coal conversion and aquatic environments: overview of impacts and strategies for monitoring. Environmental Sciences Division publication No. 1112.** Roop, R.D.; Sanders, F.S.; Barnthouse, L.W. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From 5. national conference on energy and the environment; Cincinnati, OH, USA (1 Nov 1977).

Impact assessment and environmental monitoring are difficult but crucial steps needed to ensure the environmentally safe development of coal conversion technologies. This paper summarizes strategies for impact assessment and monitoring developed at Oak Ridge National Laboratory for DOE's program to build demonstration facilities. Impacts on aquatic environments depend heavily on the abiotic and biotic characteristics of the site and details of facility design. Key issues include availability of water, use of "zero-discharge" designs, and methods of handling solid wastes. In monitoring programs emphasis is placed on (1) thorough use of existing data, (2) use of a synoptic reconnaissance survey, criteria for choosing parameters to be measured, and the search for ecologically meaningful, cost-effective methods.

11489 (EPRI-EA—421(Vol.1)) **Oxidant measurements in western power plant plumes. Final report. Volume I. Technical analysis.** Ogren, J.A.; Blumenthal, D.L.; Vanderpol, A.H. (Meteorology Research, Inc., Altadena, Calif. (USA)). Jul 1977. 119p. Dep. NTIS, PC A06/MF A01.

Airborne measurements were carried out during July 1976 at the fossil-fuel Four Corners and San Juan power plants in northwestern New Mexico. The primary purpose of the study was to ascertain the extent of ozone formation in power plant plumes. The formation of secondary pollutants (NO_2, SO_4/sup -/) in general was also studied. The program was coordinated with and provided support to another EPRI-sponsored aircraft sampling program performed at the same location.

11490 (MLM—2470(OP)) **Preliminary radiological impact assessment of western coal utilization.** Styron, C.E.; Robinson, B. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 3p. (CONF-771113—7). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

This research program was initiated to: (1) delineate the scope of the potential environmental and human health problem associated with radioactivity in Western coal; (2) establish a data base for ^{238}U, ^{210}Pb, ^{210}Po, ^{230}Th and ^{226}Ra found in Western coal; (3) study the release, fate, and accumulation of radionuclides from a power plant burning Western coal; and (4) assess the possible need for additional control technology and/or standards. Preliminary results indicate that radionuclides may be made available to the environment from burning Western coal. Lead-210 in coal used at the power plant averaged 0.79 pCi/g, ^{210}Pb in soil averaged 0.70 pCi/g, and ^{210}Pb in/on vegetation in the environs of the power plant ranged from 2.23 to 5.70 pCi/g. These values for ^{210}Pb in soil are in the range of natural background, but plants appear to have slightly elevated concentrations. Preliminary dose evaluations for ^{210}Pb alone indicated that individuals whose total vegetation intake was grown in this area could receive as much as 400 mrem/yr to the kidney, which is below the current standard of 500 mrem/yr. Although no health hazard has been identified, additional studies of ^{210}Pb concentrations in/on vegetation and of dose evaluations are being undertaken.

11491 (NP—22437) **Land resources inventory of lignite strip-mining areas, East Texas. An application of environmental geology. Geological circular 76-2.** Henry, C.D. (Texas Univ., Austin (USA). Bureau of Economic Geology). 1976. 30p. of Texas, Austin.

Large areas of the state, particularly in East Texas, will be strip-mined to obtain the lignite. Environmental geologic mapping provides much of the information necessary to plan mining and reclamation. The environmental geologic map does three things: (1) it identifies problem areas, (2) it provides basic information for planning of reclamation, and (3) it provides a regional framework for detailed studies at individual mine sites. Some examples of critical areas identified by the mapping for this study are aquifer recharge areas (sand hills and low-rolling sands) where the potential for ground-water pollution must be given strong consideration, sandy clays which are the probable substrate in which most mining will occur, and floodplains which would be hazardous areas for mining and which have highly fertile soils requiring preservation. Lignite mining in Texas is likely to be a major source of energy, a major land use, and a major job and money producer. Lignite, however, is a nonrenewable resource; once burned it is gone. Land and water are renewable resources and, if properly protected during mining, can provide food, fiber, and recreation indefinitely.

11492 Emission factors for solid-fuel firings. Davids, P.; Gliwa, H. (Landesanstalt fuer Immissions- und Bodennutzungsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.)). *Gesund.-Ing.;* **98**: No. 3, 58-68(Mar 1977). (In German).

In North Rhine Westphalia, emission control for domestic solid fuel firings has been practiced since 1970. The results from some 13,000 plants were evaluated. For the different types of fuel, the mean solids emission C and the complaint ratio B were determined using the charge/firing principle as a parameter. Excess values were found in 33% of the coke firings, 48% of the coal firings, 72% of the wood firings and 78% of the brown coal briquette firings. By relating the emission parameters to the excess air of the firings, it was found that solids emission may be minimized with all fuels when operating on CO_2 contents of mere than 10%. In plants with technical faults or soiling, the number of complaints increases. The statistical distributions of process and plant characteristics suggest that there is much room for improvements. The table of emission factors for solid, carbon monoxide, organic compounds and NOsub(x) enables a judgement of the emission behaviour of solid fuels as compared to oil or gas firings.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 11491

11493 (CONF-770233—, pp 59-62) **Let's make the most of our coal resources.** Pistole, H. (Carter Oil Co., Houston, TX). 1977.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

In Mining year book, 1977.

New coal production, technological and research capability, and capital for new projects are among the benefits which oil companies bring to the coal business. For the consumer, it can only mean increased competition and fair prices. The era of abundant, inexpensive energy is over. Very simply, the United States—and indeed the world—are now consuming oil and natural gas faster than new reserves are being discovered. Much of the future demand growth will have to be met by other fuels. Coal production in the United States must more than double within the next 15 years in order to keep our dependence on foreign fuels within reasonable limits. What we cannot do is to delay near-term decisions on coal development while we speculate on when solar energy or nuclear fusion will become available in significant quantities. Today, right now, we must all be concerned about clearing the way for development of our coal resources. The lead times are simply too long to do

otherwise. Coal is a logical area for oil company participation. More than $60 billion of new investment is required by the coal industry over the next 15 years, and oil and gas companies are already experienced at investing sufficient capital in such long-range, high risk, technology-intensive areas as coal exploration and mining. Now is not the time to legislate out of the business those investors whose skilled manpower, financial resources, and management capability are ideally suited to the development of coal for direct use as well as the development of the technology for its conversion to synthetic fuels.

11494 Colliery roof structures: a study in coal winning. *Miner. Res. CSIRO;* **12**: 3-4(Dec 1976).

A new program has been set up in CSIRO to map geological structures in coal seams and their enclosing roof and floor sediments, to delineate areas of bad roof conditions according to failure types, to investigate the relationships between geological structures and areas of roof failure, to develop predictive techniques and to determine the usefulness of directional mining advance by statistical analysis of structural geology and roof condition in colliery workings at different orientations. (LTN)

11495 Implications of coalification levels, Eureka Sound Formation, northeastern Arctic Canada. Bustin, R.M. (Univ. of Calgary, Alta.); Hills, L.V.; Gunther, P.R. *Can. J. Earth Sci.;* **14**: No. 7, 1588-1597(Jul 1977).

The rank of coal in the Eureka Sound Formation on Ellesmere and Axel Heiberg Islands ranges from brown coal to high volatile bituminous coal, based on reflectance determinations. Reflectance values from coals adjacent to the Stolz Fault, Axel Heiberg Island, are higher than in adjacent areas and may be related to abnormally high heat flows resulting from evaporite diapirism at depth, from the effect of overthrusting, or both. Regionl reflectance values indicate that there is no correlation between the degree of coalification and the age of the strata, suggesting differing depths of burial and tectonic settings. Comparison of the coalification gradient at Fosheim Peninsula, Ellesmere Island, with that of the Tejon area of California permits estimation of a geothermal gradient which can be used for calculation of preorogenic sediment thickness. Maximum temperatures derived from the degree of coalification (100°C at Fosheim) suggest that the sediments are within the zone of initial oil maturity.

11496 How large are the coal deposits exploitable in the foreseeable future on earth. Fettweis, G.B. *Glueckauf;* **113**: No. 12, 598-600(16 Jun 1977). (In German).

Author's theory expounded in his 1976 book "World Coal Resources" on limited resources is compared with statistics presented to World Energy Conference 1974. State of reserves and their availability according to various categories are discussed. Effect of new technologies and mining methods on estimates is considered. 34 refs.

MINING

REFER ALSO TO CITATION(S) 11491, 11493, 11560, 11583, 11584, 11585, 11586, 11587, 11588, 11589, 11590, 11592, 11593, 11594, 11596, 11597, 11598

11497 (CONF-770233—) **Mining year book, 1977.** (Colorado Mining Association, Denver (USA)). 1977. 192p. Mining Association, Denver.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

Topics covered include non-mineral resource management, coal, exploration and geology, minerals processing, safety, technology transfer, and mine management. Separate abstracts were prepared for 5 papers. (MCG)

11498 (CONF-770233—, pp 98-103) **Environmental program at the Belle Ayr Mine.** Cassady, J.M. (AMAX Coal Co., Indianapolis). 1977.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

In Mining year book, 1977.

Over the past five years the concern over the environmental consequences of the development of the coal reserves of the Powder River Coal Basin have resulted in the passage and promulgation of several state and Federal laws and regulations addressing these environmental concerns. The paper presents a case study of the evolution of an environmental engineering program by a major mining company (in this case, AMAX Inc.) at a major surface coal mining operation in the Powder River coal basin (in this case, the Belle Ayr Mine) to address the requirements imposed by these laws and regulations.

11499 (CONF-770233—, pp 104-108) **Forging the missing link in the environmental management chain.** Streeter, R.G. (Fish and Wildlife Service, Ft. Collins, CO). 1977.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

In Mining year book, 1977.

The Environmental management of western lands being strip-mined for coal is for the most part something we can all be proud of. Erosion control, water and air pollution controls, and reshaping and the establishment of some type of vegetative cover are generally practiced at the "state-of-the-art" level. From one to three thousand dollars per acre are being spent on just the reclamation activities alone, a sizeable cost to the operator and eventually, the consumer. State and Federal Land Management and regulatory agencies are likewise spending considerable sums in establishing standards, guidelines, and other advice related to the environmental aspects of site-specific strip-mining operations. The activities of both groups are conducted on local or relatively small-scale planning cells and, no matter how well-intended, are being hampered by the lack of an essential link or step in the entire environmental management scene—namely that of a set of integrated step-down environmental goals at state and regional levels and the associated strategic, comprehensive land-use plan. Several specific examples of the effects that such comprehensive plans would have had on site-specific actions are discussed. The development of comprehensive plans that will assure the integrity of ecosystems will require a commitment by industry and local, state, and federal governmental entities to an overall goal that will lead to negotiated, environmentally, economically, and politically acceptable compromises. The WELUT, through the Fish and Wildlife Service Office of Biological Services, has embarked upon a series of efforts geared to provide the requisite information regarding the renewable fish and wildlife resources that will be required for the knowledgeable development of the environmental portions of comprehensive land-use plans.

11500 (CONF-770233—, pp 114-131) **Western coal in the U.S. energy picture.** Lowrie, R.L. (Bureau of Mines, Denver). 1977.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

In Mining year book, 1977.

After a difficult period, coal production—particularly from the West—is making large gains. U.S. production in 1976 was 665 million tons, up 2.6 percent. Meanwhile, Western production was 132 million tons, up 19 percent. Contributing reasons include the shortages and high costs of alternate fuels at powerplant, air quality laws that are inducing a shift to low-sulfur coal, and the availability in the West of thick seams of coal that can be mined by low-cost surface methods. A sure bet for the future is that the West's ascendancy will continue because it contains 93 percent of the Nation's surface minable, low-sulfur coal. A recent (May 1976) Bureau of Mines tabulation indicated 154 new coal mines or expansions planned, proposed, or under development west of the Mississippi. Since then, 39 more projects have been added to those under consideration. Shipments to six Midwestern States in fiscal year 1976 were 33 million tons, up eightfold since 1970.

11501 (CONF-770233—, pp 132-138) **Process of developing a western coal mine.** Jones, J.R. (Peabody Coal Co., St. Louis). 1977.

From 80. national western mining conference; Denver, CO, USA (3 Feb 1977).

In Mining year book, 1977.

The major steps in the process by which an operator develops a coal mine in the West are discussed. It outlines the principal activities under each step and the prospective time to accomplish each. Some of the major constraints are reviewed, including compliance with NEPA, requirements of various federal, state, and local governmental bodies, acquisition of sufficient coal and surface reserves to satisfy a long term coal supply agreement, and delays in permit issuance. What new constraints are likely to develop in the future and during the contract with the customer. As a consequence of these and other problems, the risks in developing a new mine have increased significantly. Competitive factors play an important part in the decision to develop a Western mine. Will emissions resulting from burning the coal comply with EPA new source performance standards. What is the severance tax consideration. Can the coal compete with nuclear or coals from other areas. What are the transportation factors.

11502 (NP—22722) **Report on anthracite open pit mining: a feasibility study. Part I. Summary report. Special research report SR-103.** Manula, C.B.; Knight, C.G. (Pennsylvania State Univ., University Park (USA)). 31 Jan 1976. 37p. State University, University Park.

This report demonstrates the potential financial feasibility of deep open-pit mining of anthracite coal. It does not, however, address larger policy questions critical to further study and possible implementation of such a mining plan. Among these questions are the development of markets for the anthracite produced; the full scale assessment of social, economic and environmental impacts of

open-pit anthracite mining; estimation of costs from most favorable potential mining sites, where mining costs and relocation expenses would be minimized; optimization of mine design with respect to annual productivity, site-specific geology and reserves characteristics; community reaction to a proposal for expanded open-pit mining and potential ancillary industry developed in association with mining (primary metals processing, electric generation); and legal, social and political frameworks applicable should community relocation be required. The importance of these next steps toward decisions on anthracite exploitation should be clear in light of the feasibility analysis reported here.

11503 Webster packer, with particular reference to Hem Heath Colliery. Deakin, M.H. *Min. Eng. (London);* **134**: No. 171, 341-353(Apr 1975).

The paper describes in detail the Webster plough packing machine as currently used to pack face return ends, and subsequent modifications made to it at Hem Heath Colliery.

11504 U.S. Bureau of Mines mining research programs. Prast, W.G. *Min. Mag.;* **137**: No. 2, 115-117, 119, 121(Aug 1977).

The U.S. Bureau of Mines is carrying out a number of mining research programs, the objectives of which are in general to increae efficiency, safety and productivity in U.S. mines--particularly coal mines. In this article details of the various programs currently underway are given, covering almost all aspects of coal mining and including surface mining, oil shale mining and metal/non-metal mining. 7 refs.

11505 Nova Scotia plans big coal programs. *Can. Min. J.;* **98**: No. 7, 46-47(Jul 1977).

Major developments in the Nova Scotia coal industry, including a new open pit mine in Pictou County, a series of drilling and exploration programs, and conversion of some Nova Scotia Power Corporation generating plants from oil to coal, have been announced by Premier Gerald A. Regan. The area of interest lies west of the town of Stellarton and includes seven seams of coal. A diamond drilling program carried out in cooperation with the Department of Regional Economic Expansion indicated a potential of up to 10,000,000 tons of coal accessible by open pit mining. Work will commence on engineering feasibility including detailed diamond drilling, hydrologic studies and design.

11506 Efficiency and productivity from the shaft to the gate end. Dunn, R.B. (Natl Coal Board). *Min. Eng. (London);* **136**: No. 194, 573-577(Jul 1977).

During recent years the British coal mining industry, as a result of technical development supported by the investment program, has progressively improved performance at the coalface. The development of new technology in the control field offers a new opportunity, both to save labor and make a contribution to improved mine safety. Such a program will, however, need to be supported with a new look at mine roadways and the facilities provided within them, particularly facilities for manriding and the movement of materials. This paper reviews the background and analyzes the work involved. Reference is made to investment priorities and labor saving objectives.

11507 Dirt absorbing heading at Whitwick Colliery. Ash, J.W. (Natl Coal Board, South Midlands Area, Engl). *Min. Eng. (London);* **136**: No. 194, 591-598(Jul 1977).

This paper describes a method of developing a roadway in the Yard Seam at Whitwick Colliery in Britain, using modified mining equipment integrated to form a mining system capable of extracting coal from a thin seam and mechanically packing the ripping dirt. Acceptable rates of advance were achieved and a costing assessment is given.

11508 Shortwall mining in the USA. Blades, M.J. (Min Res and Dev Establ, Bretby, Engl). *Min. Eng. (London);* **136**: No. 194, 607-614(Jul 1977).

This paper is a report of a visit to the USA to examine and study shortwall mining as practized by the American mining industry, with a view to applying the system in the UK. Systems of mining in the USA are briefly described, the shortwall operation is outlined and reasons suggested for the emergence of shortwall coalfaces. Some existing and proposed installations are described and an assessment is made of the future of shortwall mining in the USA. The suitability for adoption of the system within the British mining industry, and its potential, are discussed. 9 refs.

11509 Bentley colliery. Watson, T. *Colliery Guardian;* **225**: No. 7, 357-358(Jul 1977).

The author describes the application of advanced technology mining at Bentley Colliery, in the U.K.'s NCB Doncaster Area. Advanced technology mining is based upon the concept of equipping faces with the best proven basic coal face machinery and adding to it, one step at a time, other proven refinements so that eventually optimum output is obtained from coal faces. The ultimate aim is to achieve the manless face.

11510 Principles of underground coal mine design--an approach--3. Lama, R.D. (CSIRO, Aust). *Colliery Guardian;* **225**: No. 7, 375-376(Jul 1977).

The final installment of this three-part paper summarizes the elements of nine design and monitoring, and recommends the finite element methods with elastoplastic and strain-softening models as very useful for general mine design purposes. It is concluded that geomechanical conditions play a vital role in solving the problems associated with mine design. 46 refs.

11511 Power loading. Morris, J.R. (Anderson Stratclyde Ltd). *Colliery Guardian;* **225**: No. 7, 389-391, 393-394(Jul 1977).

This article describes some of the more recent developments in the design of British power loaders for mechanized longwall faces, and also systems applicable to the face ends, so as to illustrate the application of the equipment and techniques to the mining industry in the U.S. The equipment highlighted includes ranging drum shearers for medium to thick seams, fixed drum shearers for medium seams and floor mounted machines for thinner seams.

11512 Application of polyurethane in installation and preparatory work. Maurer, H. *Glueckauf;* **113**: No. 14, 707-711(Jul 1977). (In German).

Physical and mechanical properties of polyurethanes are analyzed and uses in coal mining for rock and seam stabilization are demonstrated. 10 refs.

11513 Fundamentals of tectonics as basis for deposits evaluation and mine planning in the Ruhr carbon. Lautsch, H. *Glueckauf;* **113**: No. 14, 712-717(Jul 1977). (In German).

Application of geological principles to coal mining operational phases is explained. Rock processes, mechanics, deposit geometry, and residual stresses are discussed using practical examples from Ruhr District mines. 2 refs.

11514 Operational experience with firedamp-proof magnetic separators on conveyor belts. Suesse, W. *Glueckauf;* **113**: No. 14, 717-718(Jul 1977). (In German).

Belt protection achieved by using separators to eliminate iron pieces from coal is reported. Dimensions and velocity of devices are specified. 1 ref.

11515 World coal production 1976. Hoffmann, F. *Glueckauf;* **113**: No. 14, 722-724(Jul 1977). (In German).

Statistical review of stagnation in Europe and of progress in Asia, Africa, and Australia is given. 1 ref.

11516 Methane emission in mine workings with auxiliary ventilation. Noack, K. *Glueckauf;* **113**: No. 12, 608-610(16 Jun 1977). (In German).

Advance calculation methods in various types of shafts and coal faces are presented. Improved and newly conceived safety measures based on calculations are discussed.

11517 Economical materials supply with central distribution and storage. Kohlmann, E.; Brinkhoff, A. *Glueckauf;* **113**: No. 12, 610-615(16 Jun 1977). (In German).

Problems of market research, planning of demand and acquisition, and timing of purchases are analyzed. Centralization and decentralization of storage for various sites of mines underground and on surface are discussed. Conveying of materials by various means and phases of handling are described using practical situations as examples.

11518 Coal mining on the Hannover Fair 1977. Brenner, H. *Bergbau;* **28**: No. 6, 206-222(Jun 1977). (In German).

From Lecture meeting in connection with the Hannover Fair: target conflict - energy demand - environment; Hannover, Germany, F.R. (20 Apr 1977).

Exhibits of the national industry, used in mining, are reported on (working and driving equipment, drilling equipment, crushers, drive assemblies, transport equipment, lift devices, equipment for automation and remote control, pumps, filters).

11519 Possibilities of professional career in the German coal mining industry. Gierhardt, H.; Mader, S. *Glueckauf;* **113**: No. 11, 563-568(Jun 1977). (In German).

Development and age structure of the labor force. Possibilities and courses of professional training in the German coal mining industry. Choice of profession and possibilities of promotion. More advertising campaigns necessary to obtain recruits for mining work.

11520 Higher stability of long-life mine workings by systematically influencing rock behaviour. Schuermann, F.; Rauss, B. *Glueckauf;* **113**: No. 11, 539-545(Jun 1977). (In German).

The measuring roof bolt method measures by eight values the behaviour of the supporting ring around mine workings with beginning influences of coal winning. The estimation done by this method of the extent of beginning influences of mining operations serve management for the assessment of residual pillars.

11521 Emission of methane in mine workings with auxiliary ventilation. Noack, K. *Glueckauf;* **113**: No. 12, 608-610(Jun 1977). (In German).

One of the two task groups of the Colloque Interbassins 1976 was working on the problem of methane emission from mine workings with auxiliary ventilation. Of the many questions concerning emission and ventilation discussed there, various methods for the pre-calculation of emissions in mine roadway drivages are presented, some of them new and some of them greatly improved. The article closes on a catalogue of suggestions concerning increased safety in dummy roads.

11522 Transport of mass goods on the top run and bottom run of belt conveyors. Zimmermann, D. *Glueckauf;* **113**: No. 12, 600-608(Jun 1977). (In German).

For combined coal winning from the collieries 'General Blumenthal' and 'Ewald Fortsetzung' a large belt conveyor plant was taken into operation which is able to transport 1360 tons/h in the top run and 300 tons/h of dirt in the bottom run. The different types of coal are transported separately in intermittent operation with the aid of bunker systems connected to the front and rear of the belt conveyor. Persons can be transported in the top run as well as in the bottom run.

11523 Output determination based on availability in coal mining. Gerlach, R. *Glueckauf-Forschungsh.;* **38**: No. 3, 94-98(Jun 1977). (In German).

Systematic approach to coal winning, conveying and haulage is presented and a model is drawn using arbitrary durations of operation and repairs. Cases of production with and without standby faces are considered and use of interim bunkers is investigated. Economis of the processes is evaluated. 6 refs.

11524 Comparisons of shearer-loader picks. Rix, P. (Tech Hochsch, Aachen, Ger). *Glueckauf-Forschungsh.;* **38**: No. 3, 99-103(Jun 1977). (In German).

Four types of picks are investigated regarding cutting behavior, speed, plane, conditions, and depth. Test results are evaluated and relationships are established between cutting depth and force applied, and specific cutting force and thrust.

11525 Use of synthetic polymers as protective colloid in drill flushes. Haege, K. *Braunkohle;* **29**: No. 5, 197-202(May 1977). (In German).

In the Rhenish soft coal field the CMC flush, as protective colloid to obviate clay caving, was used when sinking well bores. In the search for a protective colloid which brings economic advantages with the same or better effectiveness, synthetic polymers were successfully tested in the laboratory and field. These tests showed that synthetic polymers bring advantages in respect of water hygiene as well as in the development of wells apart from their protective effect for instable layers of clay.

11526 Occurrence and phenomena of gas outbursts. Palm, K.; Menneking, F. *Glueckauf;* **113**: No. 10, 495-501(May 1977). (In German).

Gas outbursts in the German coal mining industry are considered. Occurrence and phenonema in the world are reported. A working model is presented of the outburst of gas and coal. How the danger can be recognized and counteracted are considered.

11527 Hydro-mechanical coal getting in the USSR. Ekber, B.Y.; Gorbachev, A.S. (Institut Gornogo (IGDAN), Moscow (USSR)). *Glueckauf;* **113**: No. 10, 502-509(May 1977). (In German).

The utilization of various exploitation processes making use of slopes for transportation, the use of the tie rod, and machines developed in the USSR allow the working of all thick seams in flat, sloping and steep deposits in a hydro-mechanical way. This applies for seams with difficult geological properties as well as for seams involving the risk of explosions of mine damp and dust. Furthermore, this exploitation method allows to increase the mining output by 50 to 100% compared with conventional mining methods. Its application also ensures a high degree of safety underground.

11528 Method of combating floor lift by floor bolting--3. Experimental studies on floor lift in coal mine roadways. Hokao, Z.; Yoon, J. *Nippon Kogyo Kaishi;* **93**: No. 1071, 359-363(May 1977). (In Japanese).

A series of model experiments on the mechanism of floor lift in coal mines is carried out in laboratory, and some effects of several factors (depth of roadway etc.) to the floor life are examimed. Refering to the experimental results and todays Japanese coal mines conditions, the floor bolting is applied as one of the useful methods of combating floor lift and the effect is demonstrated experimentally. Suitable materials of floor bolting are wood dowels or vinyl pipes. The relations between length of bolt and effect of bolting are shown and discussed. 10 refs.

11529 Economic statistics. Figures on mining in the Federal Republic of Germany from January until February 1977 on the basis of data from the statistics of the Kohenwirtschaft e.V. *Glueckauf;* **113**: No. 10, 524(May 1977). (In German).

The figures refer to haulage, briquetting, coke production, stockpiles, number of employees in hard coal and brown coal mining, and coal reprocessing during 1976 and the months of January and February of 1977.

11530 Stowage front dams helping support coal longwalls. Trebacz, W. *Przegl. Gorn.;* **33**: No. 5, 201-205(May 1977). (In Polish with English abstract).

Individual types of front dams for hydraulic stowage in coal mines together with individual and mechanized supports are discussed. Technical and economic results of individual solutions and directions of further investigations are given.

11531 Coal mining industry of the Soviet Union. Duczmal, M. *Przegl. Gorn.;* **33**: No. 5, 230-234(May 1977). (In Polish with English abstract).

Showing the Soviet coal mining industry against the background of world energy and fuel situations and in its historical development its last activities and effects in the range of mechanization and concentration of output are dealt with. A separate chapter includes the cooperation of the USSR coal mining industry with that of the PRR.

11532 Structure of shock-camouflet charge assuring seismic effect of destressing grounds imperiled by rock bursts. Rudnicki, B.; Wiadrowski, M.; Frei, R. *Przegl. Gorn.;* **33**: No. 5, 205-210(May 1977). (In Polish with English abstract).

A proposition is presented for a segmented charge whose explosion should assure the provacation of a ground shock necessary for creation of destressing or rock burst and loosening of the front band of solid coal to a suitable distance. 13 refs.

11533 Production results of mechanized longwall faces at Ziemowit colliery. Galeczka, S.; Niechcial, T. *Przegl. Gorn.;* **33**: No. 3, 89-93(Mar 1977). (In Polish).

The development of an integrated mechanization of Ziemowit colliery is characterized, and on the example of two longwall faces the technology and organization of work are presented together with production results attained owing to the modernization of the longwall face set. 3 refs.

11534 Improving the working of thick steeply dipping seams with stowing. Shcherbakov, L.A.; Maitak, V.S.; Borisov, Y.E. ("Gidrougol'", USSR). *Ugol;* No. 3, 21-25(Mar 1977). (In Russian).

Possible variants of effective working of thick steeply dipping seams with gobbing under complicated and difficult conditions of the Prokopyevsk-Kiselevsk region of the Kuznetsk Basin in Siberia are set forth.

11535 Problem of technological efficiency and universality of the tunneling equipment. Nil'va, E.E. (IGD im. A.A. Skochinskii, USSR). *Ugol;* No. 3, 38-42(Mar 1977). (In Russian).

Based on an analysis of geological and mining conditions, recommendations are given on standardization of the tunneling equipment and on designing new, more versatile prototypes of the tunneling equipment.

11536 Range of effective water infusion into a coal seam. Krawiec, A.; Dybel, T.; Domzal, J.; Ozana, P. *Przegl. Gorn.;* **33**: No. 3, 93-100(Mar 1977). (In Polish).

Results of tests on the determination of the radius in view of reducing the natural liability is drawn to the necessity of knowing these data for a correct humidification of the coal solid. 5 refs.

11537 Ground movements associated with the near-surface construction operations of a mine drift in coal measures strata. Whittaker, B.N. (Nottingham Univ., Eng.); Pye, J.H. *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **14**: No. 2, 67-75(Mar 1977).

An account is given of a study of strata movements resulting from the near-surface (17.4 m depth) construction operations of an arch-shaped mine drift (5.5 m excavated width). Precise surface levels and strain wire instrumentation located in boreholes ahead of the advancing drift face have allowed a study to be made of roof strata behavior and surface subsidence development both before and after undermining. The results indicate a zone of discernible uplift ahead of the advancing drift face. The horizontal extent back from the face of the zone of rapid subsidence movements of the roof strata immediately following undermining was observed to be of the order of 9 m (corresponding to 0.5 x depth). The limiting angle of draw of the final surface subsidence profile was found to be 45^{0}, although the resulting profile shows similarities with that predicted by deep mining subsidence knowledge. Problems associated with prediction of the anticipated maximum surface subsidence are discussed in relation to the principal mining dimensions, namely width and depth of the excavation. There is a general discussion on the role played by the drift formation method and the excavation support system in achieving effective roof strata control.

11538 Aachen coalfield. Schunder, F. *Glueckauf;* **113**: No. 3, 135-138(3 Feb 1977).

An account of the history of the Aachen coalfield is presented.

11539 Modern technology applied to handling coal. *Dtsch. Hebe-Foerdertech.;* **23**: No. 2, 60(Feb 1977). (In German).

Setup, application, mode of functioning, service and maintenance of a complex system for mining brown coal in the open-cast mine of Nochten (GDR) are described. The main technical details of the slewing bucket ladder excavator Es 3150 and the overburden conveyor gantry are presented.

11540 Evaluation of the effect of the reliability of equipment at longwalls with integrated mechanization on the incidence rate of industrial traumatism. Miroshnikov, S.I.; Kapsevich, V.G. (Donetsk Polytech Inst, USSR). *Izv. Vyssh. Uchebn. Zaved., Gorn. Zh.;* No. 4, 64-66(1977). (In Russian).

Traumatism at Donbas coal mines equipped with KM-87 and KM-97 integrated mining machinery and the effect on it of the reliability of equipment are considered. It is shown that, with certain values of the factors considered, the coefficient of frequency of industrial traumatism acquires a minimal value.

11541 Communications underground. Atkins, A.R.; Austin, B.A. *Coal, Gold Base Miner. South. Afr.;* **24**: No. 11, 63-67(Nov 1976).

Paper describes a radio communication network which relies on power cable and other metal conductors found in mines to enhance signal propagation. Portable transceivers communicate with a larger, more powerful base station, which may be connected by cable to a station on the surface. The system has already been used in gold mines; an intrinsically safe version is planned.

11542 Recovery machine for underground mining. Monks, H. (to Coal Industry (Patents) Ltd., London (UK)). German(FRG) Patent 2,604,906/A/. 9 Sep 1976. 7p. (In German).

The invention refers to a recovery machine with a powered hydraulic pump supplying a hydraulic motor with a hydraulic medium. This motor powers a driving and braking device of the recovery machine controlling the pressure of the medium conducted to the motor by means of a device which controls and operates the brake-mechanism whenever the pressure drops below a given value. This safety device is to prevent the driving of the recovery machine along a coal stope, the top of the coal-cutting machine functioning as driving device.

11543 Electrical properties of the country rocks of the Karaganda coalfield. Tonkonogov, M.P.; Veksler, V.A. (Karaganda Polytech Inst, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 545-553(Sep-Oct 1976).

The widths of the confidence zones for the resistivity rho, dielectric loss angle Δ, and dielectric constant $epsilon$ may reach ten, four, and two orders of magnitude respectively. For coals, sandstones, argillites, and siltstones the resistivity at 297°K, $rho$$_{297}$, is a suitable basic parameter. Investigations include: the correlations between the resistivity at 320, 423, 533, 643, and 693°K and the activation energy U of the conductivity (relation of type I); the dielectric constant and its temperature coefficient $sigma$ at frequencies of 10^4, 10^5, and 10^6 Hz at 320 and 585°K (relation of type II); the dielectric loss angle and its temperature coefficient γ under the same conditions (relation of type III); the resistivity and dielectric constant at 10^3, 10^4, 10^5, and 10^6 Hz at 297°K (relation of type IV); and the resistivity and dielectric loss angle under these conditions (relation of type V). By means of the F criterion it is shown that regressions of types IV and V are represented by a second-order equation, and the other regressions are linear. The closeness of the relation between log rho and U decreases with an increase in temperature. 4 refs.

11544 Reports on the IXth World Mining Congress and on the International Mining Exhibition at Dusseldorf May 1976. *Glueckauf;* **112**: No. 18, 1011-1100(Sep 1976).

The scientific results of the IXth World Mining Congress and the innovations of the International Mining Exposition 1976 are reviewed. The contributions deal with the following subjects: Advancing techniques, supporting techniques, mechanized drivages, blasting and blasting materials, haulage and transport, hauling track techniques, shaft haulage techniques and shaft drivages, energy, driving, and control techniques, pit ventilation, mine surveying and rock burst prevention, planning and supervision of collieries, reprocessing techniques, mining and environment, environmental impacts above ground, training and further education of mining engineers.

11545 Installation induced stresses for grouted roof bolts. Nitzsche, R.N.; Haas, C.J. (Univ. of Missouri, Rolla). *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **13**: No. 1, 17-24(Jan 1976).

The state of stress in and around conventional and grouted roof bolts has been calculated using the finite element method. The results are illustrated by calculations for two specific cases. The method is restricted to bolts installed in a repeating pattern and in the absence of joints, faults, etc. (LTN)

11546 Sudden extrusion of an inhomogeneous coal seam: basic relations. Khapilova, N.S. (Inst. of Applied Mineralogy and Metallurgy, Kiev). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 479-484(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 5, 24-30(1976).

Gas bursts are often confined to inhomogeneous boundaries in coal seams. Sudden extrusion of a worked coal seam is the initial stage of a gas burst. A mathematical model of the gas burst process was suggested by the present author and Kuznetsov using the approach suggested by Barenblatt and Khristianovich. A sudden extrusion of a worked seam, like a gas burst, is due to the formation of a zone of fractured coal. As a result, the rock pressure on the seam is redistributed and the process of sudden extrusion begins owing to convergence of the side rocks. From experience it is known that the zone of fractured coal is formed at the boundary between parts of the seam with different mechanical constants. The process of extrusion can be represented by a system of equations expressing the condition of conservation of mass for three sections of the plastic face zone. The results of computer calculations permitted conclusions to be drawn concerning constants and the depth of the seam below the surface on the possibility of a sudden extrusion.

11547 Engineering calculation of gas burst parameters. Onopchuk, B.N. (Inst. of Applied Mineralogy and Metallurgy, Kiev). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 484-487(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 5, 30-33(1976).

A method for calculating the initial parameters describing the process of expulsion of broken coal and gas into the worked-out area of a coal mine in a gas burst is suggested. The analytical relations given for the initial parameters of a burst in terms of the parameters of the preburst state of the coal seam are convenient for practical use, and can be recommended to estimate the rate of possible bursts in operations in burst-prone seams.

11548 Electrical properties of the country rocks of the Karaganda coalfield. Tonkonogov, M.P.; Veksler, V.A. (Karaganda Polytechnic Inst., USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 545-553(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 5, 96-104(1976).

Using physical measurements made over a range of temperatures, a method was developed to predict the properties of rocks from a small number of informative and readily variable basic parameters which are most sensitive to any change in the rock structure and composition. The widths of the confidence zones for the resistivity rho, dielectric loss angle delta, and dielectric constant epsilon may reach ten, four, and two orders of magnitude respectively. For coals, sandstones, argillites, and siltstones the resistivity at 297°K, rho_{297}, is a suitable basic parameter. The necessary correlation calculations were performed with a Minsk-32 computer. From the first-generation programs we processed the primary results and constructed graphs. From the second-generation programs we calculated the correlation coefficient, the coefficients of linear and parabolic regressions, their 95% confidence intervals, the F criterion, and the 95% confidence zones. The third-generation programs enable us to predict the resistivity, dielectric constant, and dielectric loss angle.

11549 Combating the methane hazard by controlling potential fields in mine ventilation networks. Walkiewicz, W. *Pr. Gl. Inst. Gorn., Komun.;* No. 671, 3-14(1976).

An investigation has been made of the effect of adjusting the air pressure distribution in the ventilation network on the flow of methane from caved wastes into production workings. The methane hazard from caved wastes depends on their position in the ventilation network. Where the wastes form a set of side branches parallel to the active ventilation network, there is no danger of a change in direction of the air flow through the wastes, and the quantity of air flow can be controlled by a suitable distribution of resistances in the side branches of the network. The direction of airflow through wastes positioned diagonally to the active ventilation network may vary according to the resistances of neighbouring side branches. To avoid the occurrence of dangerous situations, the location of regulating dams should be preceded by analysis of air pressure distributions on the working faces. Suitable control of these pressure distributions can be of major assistance in degassing the wastes.

11550 Surveillance of highly stressed shaft winding ropes. Ulrich, E.; Grupe, H. *Glueckauf;* **111**: No. 18, 870-874(18 Sep 1975). (In German).

Weakening of highly stressed winding ropes is mainly due to wire breaks caused by fatigue. Topics discussed include the length which is weakened by a wire break, decisions on how far within the permissible limits the weakening is, rope length and diameter measurements, and the graphical representation of the number and position of breaks. Since the number of wire breaks increases ap-

proximately exponentially with time, the time at which a rope must be replaced can be forecast.

11551 Ukraine coal mines in 1974. Frisch, H. *Glueckauf;* **111**: No. 15, 719-721(7 Aug 1975). (In German).

Figures for total production (with separate values for coking coal), details of numbers of faces, face lengths, rates of advance, and different aspects of mechanization are given for each of the coal combines in the Ukraine. Information on the most productive faces at a number of pits is also presented.

11552 Control of strata movement around face ends. Szwilski, A.B.; Whittaker, B.N. *Min. Eng. (London);* No. 174, 515-525(Jul 1975).

Face-end layouts are classified and the important strata control implications of each system reviewed in respect of the influence of strata pressures on immediate and longer term stability.

11553 Technical developments in French coal mines. *Ann. Mines;* 9-26(May 1975). (In French).

An account is given of developments over recent years relating to working of very steep seams, of thick seams, and longwall working of flat seams, transport of men and materials, drifting, underground telemetry, automation in shafts and surface plant, and utilization of colliery waste.

11554 Similarities between ground movement around soft ground tunnels and longwall mining excavations. Farmer, I.W.; Attewell, P.B. *Min. Eng. (London);* No. 172, 397-403(May 1975).

Paper examines the similarity between ground movement--particularly settlement or subsidence--above soft ground tunnels and longwall mining excavations. Detailed measurements of ground deformation around a tunnel in clay suggest a similar deformation mechanism to that proposed by several workers to explain deformation around a caved longwall mining excavation.

11555 Theory and experiments concerning engagement of chains with sprockets and indented wheels. Pechalat, F. *Ind. Miner. (St.-Etienne, Fr.);* **2-75**: 293-324(May 1975). (In French).

Work at Cherchar was aimed at defining the factors affecting the engagement of chains, the optimum dimensions of teeth and indentations, the strength of materials used and ideal conditions of operation.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 11418, 11485, 11506, 11507, 11508, 11517

11556 (FE—2520-2) **Characterization of the chemical comminution of coal. Second quarterly report, January—March 1977.** Datta, R.S. (Syracuse Research Corp., N.Y. (USA)). Jul 1977. Contract EX-76-C-01-2520. 42p. Dep. NTIS, PC A03/MF A01.

During the period of this report, small laboratory samples were made for all the coals. Fragmentation rate studies were carried out on the following coals: Anthracite (PSOC No. 085); Semianthracite (PSOC No. 379); Low Volatile Bituminous (PSOC No. 317 and PSOC No. 318); and Medium Volatile Bituminous (PSOC No. 259 and PSOC No. 258). The Upper Kittanning coal (PSOC No. 259) fragments at a slower rate than Lower Kittanning coal (PSOC No. 258) in anhydrous liquid ammonia. When hydrous liquid ammonia is utilized for chemical comminution, the ammonia concentration determines the fragmentation ability of the solution. With NH_3 concentrations greater than 75 percent, both the Upper and Lower Kittanning samples fragment at the same rate. However at concentrations lower than 75 percent, the Upper Kittanning is less susceptible to chemical fracture. The difference in the effectiveness of gaseous ammonia to fragment the Lower and Upper Kittanning coal is evident in graphs presented. The size distribution of the chemically treated Upper Kittanning coal is considerably coarser.

11557 (FE—2520-3) **Characterization of the chemical comminution of coal. Third quarterly report, April—June 1977.** Datta, R.S. (Syracuse Research Corp., N.Y. (USA)). Aug 1977. Contract EX-76-C-01-2520. 62p. Dep. NTIS, PC A04/MF A01.

The effect of various reaction conditions (pressure, reaction time, chemical) on the fragmentation of different ranks of coal was studied. In anhydrous liquid ammonia, at atmospheric pressure, low volatile bituminous and lower ranked coals can be fragmented at a faster rate and to a greater extent than at higher pressures. However, higher pressures are required to enhance the fragmentation of semianthracite and higher ranked coals. For any one set of reaction conditions there is a limit to which the coal can be fragmented. On increasing the exposure time there is a progressive decrease in the final size consist of the samples, until a point is reached when any further exposure does not produce any more fragmentation. All other conditions remaining constant, an increase in the reaction pressure increases the rate at which the total fragmentation takes place. With gaseous ammonia at atmospheric pressure little or no fragmentation took place; increasing the pressure caused progressively greater fragmentation. For all ranks of coals with the exception of high volatile B bituminous, drying enhances the fragmentation in anhydrous liquid ammonia. Ammonia-water solutions generally tend to effect fragmentation at a slower rate than anhydrous ammonia. Gaseous ammonia fragments at a slower rate and to a lesser extent than anhydrous ammonia. Oven drying the coals, with the exception of semianthracite, low and medium volatile bituminous and lignite, reduces their susceptibility to fracture by gaseous ammonia. Gaseous ammonia fragments anthracite at a faster rate to a finer size than anhydrous or hydrous liquid ammonia. Low and medium volatile coals can be fragmented to a faster rate and to greater extent than all other coals.

11558 Planning and construction of a modern coal preparation plant extending "Lohberg" mine. Hennig, H. *Aufbereit.-Tech.;* **18**: No. 6, 259-273(Jun 1977). (In German with English abstract).

Along with an increase in output from 10,000 to 13,000 t/day, the daily dressing capacity has been raised by 10,000 t/day, i.e. from formerly 20,000 to a maximum of 30,000 t/day of washery feed coal. After a second skip hoist has been installed, the shaft hoisting tonnage now equals 1450 t/h. A blending and stockpiling section capable of storing 40,000-60,000 tons of washery feed coal is roofed to minimize environmental nuisance and set up behind the shaft hoisting section in front of the dressing installation. It is using no more than one large machine for each process step in the dressing section. Full utilization of the hourly capacity of the washery by a continuous 3-shift operation during 5 working days/week is achieved. The new machine designs do not require daily servicing during standstills.

11559 Tests to determine pressure losses in horizontal pneumatic stowing pipelines. Palarski, J. *Przegl. Gorn.;* **31**: 37-44(Jan 1975).

Tests carried out in underground conditions during pneumatic stowing are reported and the results are interpreted. Equations for the calculation of parameters of pneumatic transport of material in horizontal pipelines are given, together with recommendations relating to the quality of the material and to the parameters of the stowing installation.

11560 Cross-pit conveyor systems. Frizzell, E.M.; Martin, J.W. (US Bur of Mines, Spokane Min Res Cent, Wash). *Min. Congr. J.;* **63**: No. 8, 67-76(Aug 1977).

The reasoning outlines the following objectives for a possible overburden handling system coupling a continuous transport system with a dragline; utilize proven cost effectiveness of drag line; increase system output; increase economical mining depths; and integrate economical procedures.

11561 Mild, protective and efficient procedure for grinding coal: cryocrushing. Solomon, J.A.; Mains, G.J. (Okla State Univ, Stillwater). *Fuel;* **56**: No. 3, 302-304(Jul 1977).

Conventional grinding methods are harsh and produce dramatic changes in coal. When coal, initially at room temperature, is ground in the presence of air, the high localized temperatures produced are known to cause both the production of gases and surface oxidation. These perturbations make meaningful measurements on the product very difficult. A technique that minimizes these effects is the pulverization of coal in liquid nitrogen. Compared with conventional methods, the process is rapid and appears to be less destructive chemically.

11562 Coarse and fine grain separation in one single separator. Leininger, D. *Glueckauf;* **113**: No. 7, 666-667(Jul 1977). (In German).

Development of sieving procedures at the Saar preparation works is described. Continuous 24-hr' operation of device separating in the 50 to 0.5 mm range is analyzed. Cost reduction following rebuilding of plant is evaluated. 1 ref.

11563 Formation and filtration of flakes from coal slurries. Sinth, B.K.; Clement, M.; Juentgen, H. (Tech Univ, Clausthal, Ger). *Glueckauf-Forschungsh.;* **38**: No. 3, 115-120(Jun 1977). (In German).

Effect of flocculating agent on size and size distribution of flakes is investigated. Differences in behavior of coal and dirt particles are analyzed and effects of pH value and electrolytes concentration on flocculation are discussed concerning changes of surface properties and flocculability. 5 refs.

11564 Screening machines for modern preparation plants. Mandrella, H. *Glueckauf;* **113**: No. 10, 506-509(19 May 1977). (In German).

Various equipment is described and compared, such as resonance and flexible-drive screens, and double drive, free swinging screens. Speed and inclination of screens, and bearings used are analyzed. Principles of operation of the "Screener 2000" machine are expounded. 1 ref.

11565 Olifloc process. A method for dewatering and grading of finest slurries with a particle size less than 0.1 mm used in coal preparation. Bogenschneider, B. *Aufbereit.-Tech.;* No. 5, 219-224(May 1977). (In German).

The olifloc process offers a means for avoiding the safe but by far most expensive process for separating water, i.e. thermal drying, when upgrading superfine slurries. However, so far it has only been applied on a semi-industrial scale. The coal particles can be selectively subjected to hydrophobic treatment in suitable mixing reactors. They agglomerate whereas the mineral particles remain in suspension. in the course of an additional operation, the agglomerates are separated from the tailings and substantially from free and adhering water by suitable methods.

11566 Method for investigating the wear of the grinding parts of coal mills. Panoiu, N.; Biclesanu, D.; Craciuneanu, C. (Polytech Inst, Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 277-287(Apr-Jun 1977).

This paper describes a method for investigating the wear of grinding parts of coal mills by means of experimental tests. The experimental results are corrected and then the equations of the curves of wear variation are integrated.

11567 Method and device for drying wet bulk material, especially coking duff. Unger, G. German(FRG) Patent 2,542,670/A/. 31 Mar 1977. 13p. (In German).

Starting from the fact that during the drying of coking duft particularly large amounts of dust occur the invention aims at taking the dust away from the drying process without expensive dust catchers. The proceeding is as follows: The bridge steam of predrying and the flue gases are seperated from the bulk material and passed off before the drying continues. During its further drying the bulk material is kept apart from the burner flame and its flue gas. The process is based on the knowledge that the generation of dust only starts when the pre-drying ends. The residual moisture is said to be 10-12%. The drying equipment is described.

11568 Slurry pipelines: an innovative approach to mineral development in South America. Cameron, R. *Three R Int.;* **16**: No. 2, 79-81(Feb 1977).

To date, the majority of slurry lines have been built or are planned for transportation of coal and minerals. They have proven versatility for a series of purposes. Described are some projects in this area. With the adaptation of the technique to increased uses such as waste disposal, with inherent economics of pipeline versus other modes of transportation, and with increasing world population and accompanying need for manufactured products, slurry has a bright future.

11569 Role of operating variables in oil-agglomeration of coal. Bhattacharyya, R.N.; Moza, A.K.; Sarkar, G.G. (Central Fuel Research Inst., Dhanbad, India). pp 931-938 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

In recent years, increased attention is being paid to the application of oil-agglomeration technique for (a) improved recovery of low-ash clean coal, (b) effective beneficiation of low-grade coking coals and (c) removal of pyrite sulphur from high-sulphur coals. In this technique, which has been proved to be more effective than conventional froth-flotation, advantage is taken of the oleophilic nature of finely ground coal to separate it under controlled conditions from the associated minerals which are hydrophilic in nature. Unlike froth-flotation, no aeration is needed in the process and the concentrates which are obtained in the form of agglomerates or micro-pellets have easier dewatering characteristics. Optimization of operating variables in treating different raw feeds is a pre-requisite for the successful application of this process. A 10 gram batch unit was employed in the present test series. This paper presents results from these investigations on such operating variables as size of coal, amount of oil used, time of stirring, rate of stirring, solid content in slurry, and effect of conditioning.

11570 Some fundamental aspects of the selective agglomeration of fine coal. Swanson, A.R.; Bensley, C.N.; Nicol, S.K. (Broken Hill Proprietary Co., Ltd., Shortland, New South Wales). pp 939-951 of In Agglomeration 77. Volume 2. Sastry, K.V.S. (ed.). New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1977).

From Annual AIME meeting; Atlanta, GA, USA (Mar 1977). See CONF-770312—P2.

An experimental study of the process parameters controlling the selective agglomeration of raw coal slurries is described. Particular attention has been paid to the influence of input variables on agglomerate size and process kinetics. These factors were considered to be of paramount importance as they determine the selection and sizing of the process equipment. The variables studied include oil addition, pulp density, agitation rate and particle size of the feed. The results have been qualitatively interpreted in terms of a classical reaction kinetic model.

11571 Method and device for drying coal. Kemmetmueller, R. (to Waagner-Biro A.G., Vienna (Austria)). German(FRG) Patent 2,342,184/B/. 23 Dec 1976. 4p. (In German).

The invention refers to a method for the preheating of coal up to more than 150°C while reducing the sulfur content of coal. The preheating is executed by means of waste heat from the coke production process. Waste heat from coke dry quenching is at least partially inserted into the flow medium medictly over an intermediate heat carrier and into the fluidized bed dryer indirectly as a heating medium over heating surfaces. According to a further characteristic of the invention, coal particles and CaO pellets or MgO pellets are heated in the dryer for the purpose of desulfurization. The CaO pellets resp. MgO pellets which are to absorb the hydrogen sulfides, have a larger diameter than the coal particles and are therefore mechanically separated.

11572 Device for dry cooling of redhot coke. Okada, Yutaka; Sasaguri, Kyoji; Ishihara, Kazuo. (to Nippon Kokan K.K., Tokyo). German(FRG) Patent 2,450,803/B/. 23 Dec 1976. 5p. (In German).

The aim of the invention is a device for cooling redhot coke in such a way that a low pressure is automatically built up in the upper part of a dry quenching chamber during loading. The construction of this device is described.

11573 Computer optimization of Steiner-Weber networks by the gradient method. Strekachinskii, G.A.; Ordin, A.A. (Inst of Min, Acad of Sci of the USSR, Novosibirsk). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 537-540(Sep-Oct 1976).

The main difficulty in the solution of the Steiner-Weber problem is that it is nonlinear and multiextremal, and has no analytical mode of solution, but only a set of local minima. Structurally a Steiner-Weber network is a tree (graph), the crown and roots of which can be arranged in any way. After selection of the root, each tree gives definite consequences--a hierarchy of territories, where the root of the tree is on the highest level of the hierarchy. To avoid a trivial enumeration of all variants of construction of the network, one must establish in advance which is the case with a global minimum of function, i.e., one must establish a criterion of optimality of the network structure and find its extremum. In turn, the structure of the network depends on the mode of grouping of the vertices of the tree. A graphical solution for networks linking coal mines with dressing plant is presented. 3 refs.

11574 Pavlograd central washery. Gorbach, R.F.; Pukhal'skaya, V.A.; Klinin, V.M.; Nedobor, S.D.; Vorob'ev, G.G. *Coke Chem., USSR (Engl. Transl.);* No. 4, 8-10(1976).

Translated from Koks Khim.; No. 4, 8-10(1976).

The design of a new 5 million tpy coal preparation plant is described: receiving unit for grinding, blending, storage, etc.; magnetic separation; screens; heavy medium separation, jigs, suspension washing, dewatering, drying, and tailings disposal. (LTN)

11575 Acoustic classification of coal pulps. Yamshchikov, V.S. (Moscow Mining Inst.); Rekhtman, V.I.; But, A.B.; Butovetskii, V.S.; Nadyarnyi, L.K. *Coke Chem., USSR (Engl. Transl.);* No. 4, 11-15(1976).

Translated from Koks Khim.; No. 4, 10-13(1976).

The results of experimental and theoretical studies of coal-pulp classification are reported. A pilot-commercial acoustic classifier is described and test data are given. Inadequate initial classification is known to have a bad effect on the entire technical and economic performance of coal washeries. For instance, if the jig feedstock retains around 10% of <0.5 mm fines the process becomes sluggish; the concentrate quality is lowered and the tailings retain too much lost coal. Conversely, nearly all the >0.5 mm coal particles left in the flotation pump are lost in the tailings. The UkrNIIUgleobogashchenie Institute has developed a coal-cleaning system whereby classification is completed in the initial stages, before any cleaning operations. This approach to classification improves the cleaning and dewatering processes and very considerably simplifies the water-slurry flowsheet of the entire plant. The isolation of slurry in the initial stages of processing prevents its subsequent accumulation and circulation. This system can be adopted by installing efficient, high-throughput and compact classifiers in the sections where incoming coals are prepared initially for cleaning. Experiments with low-frequency pneumatic vibrators have shown that they provide a successful answer to the problem.

11576 Bases for planning a hydraulic transport system. Gaessler, H.; Prettin, W. *Glueckauf-Forschungsh.;* **36**: 185-194(Oct 1975).

Hydraulic transport measurements carried out at Poertingsiepen—Carl Funke Colliery showed that the application of hydraulic transport of run-of-mine coal offers technical and economic advantages for moving coal to the surface. The results obtained confirmed theory for the determination of pressure losses and energy requirements, and enabled the calculations to be extended to high material

concentrations. A relationship was obtained for the wear in straight pipelines.

11577 Solids pipelining: is it due for a breakthrough in mining and quarrying. *Mine Quarry;* **4**: 32, 34(Jul 1975).

Brief details are given of the Black Mesa pipeline, a limestone pipeline to Calaveras cement plant in California, the Dunstable-Rugby limestone pipeline and a projected coal line in S. Africa. There is also a short section on underground pipeline transport of coal.

11578 Soviet slurry pipelines. *Min. J. (London);* **284**: 302(18 Apr 1975).

Some 30 pipelines are projected for construction in the USSR, mostly for transporting fuel and energy resources from Siberia. Several underground pipelines are planned to carry iron ore over long distances from the region of the Kursk magnetic anomaly. A 3km pnuematic line is in operation in Georgia for transporting crushed stone, and another with a capacity of 6 million t/year is under contruction in the Moscow region.

COMBUSTION

REFER ALSO TO CITATION(S) 12096

11579 (FE—2018-8) **Fundamentals of nitric oxide formation. Quarterly progress report, March 11—June 10, 1977 in fossil fuel combustion.** Houser, T. (Western Michigan Univ., Kalamazoo (USA). Dept. of Chemistry). Jul 1977. Contract EX-76-C-01-2018. 12p. Dep. NTIS, PC A02/MF A01.

A study of the reaction mechanism which leads to NO formation from fuel-nitrogen by determining the rates and mechanisms of pyridine pyrolysis and HCN formation was continued. The emphasis was on the determination of the rate of formation of HCN in an inert atmosphere since in previous studies it was found to be the major nitrogen-containing product during pyridine pyrolysis at higher temperatures. Using a picric acid-colorometric method for the analysis of HCN, the ratios of moles HCN produced/mole pyridine consumed have been determined at 900, 950 and 1000°C. Since these ratios increased with reaction time and were independent at initial concentration, the data were consistent with a consecutive reaction mechanism, the second step of which was first-order. The rate constant for this second step is described by $k_2 = 10^{11.0} \exp(-63{,}400/RT)(sec^{-1})$. The infrared spectra of the cyanogen oxidation products were further analyzed. Evidence for CO as well as CO_2 and N_2O was found, but NO and NO_2 were clearly not significant products. Only one absorption, at 1030 cm^{-1}, could not be accounted for by the products listed; the origin of this band is still unknown.

11580 Recent developments in fluidized bed combustion and potential benefits to the coal industry. Gibson, J. (Natl Coal Board, Coal Res Establ, Stoke Orchard, Cheltenham, Engl). *Min. Eng. (London);* **136**: No. 194, 599-606(Jul 1977).

After 10 years of research and development, fluidized combustion is now at a position where demonstration prototype units have been, or are about to be, built for several applications. The development of the method and its potential application to power generation in conventional and advanced cycles are described. Its use in substitution for oil-firing in compact new and existing boilers and furnaces is possible following the successful operation of a 600 kW conventional hot water boiler and a 1.2 MW horizontal shell type stream-raising boiler. Economic assessments confirm advantages over conventional coal burning systems of lower capital and running costs, greater operational amenity and the capacity to reduce emissions to acceptable environmental requirements. 7 refs.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11500, 11517, 11523, 11529, 12574

11581 Research in coal. Analyses of economy. Developments in Australia and South Africa. New technologies of electricity generation. Hoffmann, F. *Glueckauf;* **113**: No. 9, 479-484(May 1977). (In German).

Conference papers on economic aspects of coal conversion, coal gasification and liquefaction in Australia and South Africa, as well as on coal and electric power generation are summarized. Also, the basic general report of the vice chairman of the NCB, N. Siddal, is dealt with, which was the first lecture held during the Third International Coal Research Conference in Sydney.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11490, 11494, 11506, 11516, 11536, 11540, 11546, 11547, 11550

11582 (SAN/1126—1) **Environmental research to support the development of fossil energy technology options. Final report.** Greenfield, S.M.; Husting, E.L.; Payton, T.O. (Greenfield, Attaway and Tyler, Inc., San Rafael, Calif. (USA)). 31 Oct 1976. Contract EY-76-C-03-1126. 161p. Dep. NTIS, PC A08/MF A01.

Existing data are not adequate for the accurate assessment of probable hazards which may be associated with coal conversion on a commercial scale. Further, although the various coal conversion processes are in different stages of development, it is difficult to predict which processes may be successfully commercialized. Knowledge of processes in the developmental stage should not be directly extrapolated to predict characteristics of eventual commercial scale plants. Although some of the occupational health and safety hazards likely to be encountered are common to other industries, there remain some questions regarding the possibility of new or unique hazards specific to the new technologies. There is considerable precedent in occupational epidemiology for surveying entire industry groups. This approach has limitations, but is valid and can be used effectively. In the instance of developing fossil fuel technology, such industry-wide epidemiological studies will be essential. It cannot be known for a period of years to what extent these studies may be comprehensive in identifying potential hazards, and to what extent the standards to be developed may be protective. In the interim it is essential that an integrated approach be mobilized. This should include periodic epidemiological assessment of work populations in coal conversion facilities. A comprehensive approach is outlined. It is apparent that numerous industrial groups and a variety of government groups have activities in the occupational safety and health aspects of coal conversion. It is important that these be coordinated and that areas of responsibility be delineated.

11583 Review of the prevention and control of dust in British coal mines. Goddard, B. (Natl Coal Board). *Min. Eng. (London);* **136**: No. 194, 579-590(Jul 1977).

The past two decades have seen tremendous upsurges in coal production with the inevitable increase in dust produced. There has also been greater stress on the importance of the environment, particularly from the ventilation and dust aspects. The problems arising from penumoconiosis are high in terms of human suffering and financial costs, and are proving that it is a most intractable disease. This paper outlines some of the causes and effects of the disease, together with respirable dust standards which are applied to minimize the risk. Methods of dust control techniques, the importance of pre-planning, the importance of ventilation, the wide use of water externally, both with machines and as a pre-wetting method before coal extraction, are discussed.

11584 Early detection and prevention of gas bursts. Paul, K. *Glueckauf;* **113**: No. 7, 656-662(Jul 1977). (In German).

Determination of gas content and of pressure in burst-prone layers is made, and coal strength decrease and stress zones near the surface are analyzed. Measurements of desorption values is explained and a new instrument for fast Δ value determination is introduced. Sandstone and methane bursts are described and depressurizing by means of boreholes is discussed. 6 refs.

11585 Accident trends in German coal mining compared with other industries. Rauch, K.H. *Glueckauf;* **113**: No. 7, 662-666(Jul 1977). (In German).

Statistical analysis for the 1960-75 period is given of 90% of employees covered by insurance. Surface and underground cases are compared. 4 refs.

11586 Gas bursts occurrence and phenomena. Palm, K.; Menneking, F. *Glueckauf;* **113**: No. 10, 495-501(19 May 1977). (In German).

Outbursts in coal mines world wide are analyzed and gas, coal, and rock quantities involved are estimated. Circumstances under whcy occurrences are frequent, and their extent are tabulated, and possible causes are related. A working model is constructed, related phenomena are evaluated, and prevention measures are suggested.

11587 Prediction of gas burst hazards by concentration of paramagnetic centers. Artemov, A.V.; Frolkov, G.D. (Novocherkassk Polytech Inst, USSR). *Ugol;* No. 5, 22-24(May 1977). (In Russian).

Prediction of potential gas burst hazards in coal mine seams of the Donbas is given, relying on data about the concentration of paramagnetic centers in the coal. Rough values of the index characterizing the hazardous zone are presented. Use of the method of electronic paramagnetic resonance to study the structure of the coal seams and to predict their predisposition to gas bursts is explained.

11588 State of investigations in the field of forecasting and combating rock bursts. Szczurowski, A. *Przegl. Gorn.;* **33**: No. 5, 198-201(May 1977). (In Polish with English abstract).

Problems connected with rock burst hazards are presented, especially in connection with the increasing mining depth. The actually known and used methods are given as well as principal trends of activity in order to get them under control.

11589 Econometric analysis of the number of accidents in production faces and headings of coal mines. Wanat, J.; Gruca, P. *Przegl. Gorn.;* **33**: No. 5, 223-229(May 1977). (In Polish with English abstract).

The tendency to changes in time of the frequency and structure indices of accidents calculated for production faces and headings is presented. Using the principle of uncharged prediction values of analyses indices to 1978 are forecast for each type of mining faces. 7 refs.

11590 Optimum flow rate of air in the current sweeping the longwall face. Myszor, H. *Przegl. Gorn.;* **33**: No. 3, 105-113(Mar 1977). (In Polish).

Results of tests on the effect of air flow rate in the current sweeping the longwall face on firedamp emission are presented. It is found that the firedamp emission decreases with the increase in the rate of air flow, the amount of emission depending on the way of controlling the rate of air flow. Consequently, the variation in the firedamp emission is caused by the variation of depression conditions in the zone of the longwall face which result in variation of the range of drainage of rock mass disturbed by mining work. A hypothesis confirmed by the findings is advanced that the relation of firedamp emission V$sub M$ to the rate of air flow V$sub p$ may be emission V$sub M$ to the rate of air flow V$sub p$ may be well characterized by the general formula V$sub M$=aV$sub p$$sup 2$+b. A hypothesis that for every longwall face and for a determined way of control there is an optimum value of rate of air flow is advanced. A method for determination of the optimum value of the rate of air flow is presented. 9 refs.

11591 Evaluation of mine shock hazard at working faces. Tarasov, B.G.; Murashev, V.I.; Dyrdin, V.V. (Kuznetsk Polytech Inst, USSR). *Ugol;* No. 3, 15-19(Mar 1977). (In Russian).

A method of determination of the possibility of the onset of a mine shock rift situation at a coal mine working face is presented. It is based on a complex electrometric method relying on the use of the parameter of the natural steady-state electric field of the seam due to mechanical stresses.

11592 Opening-up gas-burst-hazardous seams of Donbas in difficult geological and mining conditions. Khorunzhii, Y.T. (Makeyevka Sci Res Inst for Min Ind, Ukr SSR). *Ugol;* No. 3, 27-30(Mar 1977). (In Russian).

A method of opening-up seams that present gas burst hazards, by means of hydraulic washing-out of the coal body is described. The method has been developed by the Makeyevka Scientific Research Institute. The washing-out is carried out through boreholes drilled from the face into the coal body. The washed-out cavity must be 1-1.5 times bigger than the cross-sections of the working concerned.

11593 Improvement of safety and efficiency of the pillar system of working gently sloping seams presenting gas burst hazards. Zel'vyanskii, A.S.; Kaufman, L.L.; Bakulin, N.V. (Donets Sci Res Coal Inst, USSR). *Ugol;* No. 3, 31-33(Mar 1977). (In Russian).

Variants of the pillar system of working are considered from the point of view of ensuring two exits to a fresh air stream for workers after the occurrence of a coal and gas burst in a longwall.

11594 Preplanned ventilation districts world aid proto teams. *Coal, Gold Base Miner. South. Afr.;* **24**: No. 12, 41-57(Dec 1976).

Methods of fighting mine fires which are used in South Africa are described. In coal mines, stoppings are usually inserted to cover a wide area around the fire and are then gradually moved in. Burning material may be brought to the surface. Underground timber packs may be protected by fiberglass insulation blankets. The equipment used by rescue terms working in irrespirable atmospheres is listed, and training of rescue men is briefly described.

11595 Seismoacoustic signals detected in pits in the donets coalfield. Ivanov-Shits, N.K. (A.A. Skochinskii Inst of Min, Lyubertsy, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 474-479(Sep-Oct 1976).

The spectra of the higher-frequency components of seismoacoustic signals from various sources in any coal seam have maxima at the same frequencies; there is a definite relation between the frequencies of these maxima and the thicknesses of the seams; the frequencies of the maxima decrease as the seam thickness increases. For seams in the Donets coalfield with thicknesses of 0.5-2.0 m, these frequencies lie in the range from 800 to 300 Hz. The shape of the noise signal pulses is practically the same as that of the acoustic emission pulses. Thus the duration of the pulses is a direct function of their amplitude, and selection by duration is practically equivalent to selection by amplitude. All seismoacoustic signals detected in a coal seam carry information on its mechanical properties. A change in properties, and in particular in the state of stress of the coal, should cause a shift in the spectral maximum; an increase in the hardness of the coal or in the rock pressure should cause a shift toward higher frequencies, and a decrease should cause a shift toward lower frequencies. This relation can be used to predict burst-prone or burst-safe states of the coal. 6 refs.

11596 Sudden extrusion of an inhomogeneous coal seam: basic relations. Khapilova, N.S. (Inst of Appl Mineralogy and Metall, Acad of Sci of the Ukr SSR, Donetsk). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 479-484(Sep-Oct 1976).

A sudden extrusion of a worked seam, like a gas burst, is due to the formation of a zone of broken coal. As a result, the rock pressure on the seam is redistributed and the process of sudden extrusion begins owing to convergence of the side rocks. From practice it is konwn that the zone of broken coal is formed at the boundary between parts of the seam with different mechanical constants. Suppose that the plastic state of the coal in section (x$sub 1$$sup 0$, x$sub 2$$sup 0$) is characterized by an intensity of tangential stresses k, and that in section (x$sub 3$$sup 0$, x$sub 4$$sup 0$) by k$sub 1$. It is assumed that a uniformly distributed pressure P acts on the seam from the rock along the whole length of the zone of broken coal, and it is possible to represent the process of extrusion by a system of equations expressing the condition of conservation of mass for three sections of the plastic face zone. The form of the complex function of the stresses is given and the system can be numerically integrated to determine the dependences x$sub i$=x$sub i$(s)$sub 1$ P=P(s). 5 refs.

11597 Engineering calculation of gas burst parameters. Onopchuk, B.N. (Inst of Appl Mineralogy and Metall, Acad of Sci of the Ukr SSR, Donetsk). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 5, 484-487(Sep-Oct 1976).

An engineering calculation of the intial parameters describing the process of expulsion of broken coal and gas into the worked-out area of a coal mine in a gas burst is presented. The analytical relations for the intial parameters of burst in terms of the parameters of the preburst state of the coal seam are convenient for practical use, and can be recommended to estimate the rate of possible bursts in operations in burst-prone seams. 1 ref.

11598 Suppression of a mine fire at Osterfeld Colliery by injecting nitrogen. Kugler, U.; Schewe, A. *Glueckauf;* **111**: No. 10, 467-472(15 May 1975). (In German).

An account is given of measures taken to suppress a fire in a worked-out area at Osterfeld Colliery.

REGULATIONS

REFER ALSO TO CITATION(S) 11498, 11501, 12610, 12611

11599 Critical paths to coal utilization. Hill, G.R. (Electric Power Research Inst., Palto Alto, CA). *Int. J. Energy Res.;* **1**: No. 4, 341-349(1977).

The present dilemma of energy producers, converters, and policy decision makers is presented. The consequences of environmental control regulations, coupled with the need for conservation and energy, and of energy resources on the increased utilization of coal, are discussed. Several recent technical accomplishments that make possible increased utilization of coal for power generation are described. Groundwork is laid for discussion of the technical development that must occur if the United States is to retain its energy viability.

PETROLEUM

11600 Forecast of energy consumption in the ECAFE region during the decade 1965—1975. pp 10-17 of In Proceedings of the fourth symposium on the development of petroleum resources of Asia and the Far East. New York; United Nations (1973).

From 4. symposium on the development of petroleum resources of Asia and the Far East; Canberra, Australia (27 Oct 1969).

See CONF-691079—P3.

The forecast is linked with the Gross Domestic Product of the member countries during the 1965-1975 period. Past demand trends are reviewed and future consumption is forecast for solid fuels, liquid fuels, gaseous fuels, hydroelectric power, and atomic energy. (JRD)

RESERVES

REFER ALSO TO CITATION(S) 11601, 11612

GEOLOGY AND EXPLORATION

11601 Results of petroleum exploration work and tasks for the tenth five-year period in the tatar assr. Muslimov, R.K. (Tatar Pet, USSR). *Geol. Nefti Gaza;* No. 5, 12-20(May 1977). (In Russian).

Data are given on the geological exploration for oil in the Volga Tatar Autonomous Republic (including 3 map diagrams). It has been found that the western half of the Republic has no oil, Some new deposits have been found in the eastern part of Tataria and a thorough review of old deposits has been carried out to see if any promising structures have been missed. It is estimated that by now about 70% of promising oil deposits have been discovered. On the whole, however, the plan of oil reserve increase has not been fulfilled. Many new deposits contain highly viscous oil for which methods of extraction have not yet been worked out.

11602 Oil and gas potential of Miocene deposits of baku archipelago. Kheirov, M.B.; Khalilov, N.Yu. (Az SSR Sci Res Pet Inst). *Geol. Nefti Gaza;* No. 5, 38-42(May 1977). (In Russian).

Results of studies of the Miocene deposits of Baku Archigelago are presented. The data accumulated testify about oil and gas potential of these deposits. In this connection, it is recommended to continue exploratory and prospecting work in these deposits within the limits of Baku Archigelago.

11603 New model for fracture gradient. Athaus, V.E. (Exxon Co, Houston, Tex). *J. Can. Pet. Technol.;* **16**: No. 2, 98-108(Apr-Jun 1977).

For the past 18 years, fracture gradient has been thought to be some function of overburden stress, horizontal stress and internal fluid pressure. Each author that has published in the intervening years has refined this idea. This paper derives such a model, but then uses the same data to turn the entire relationship around to derive and support a new model with the following attributes: (1) Fracture gradient is equal to the least stress field in the earth. (2) Fracture gradient is independent of the fluid pressure gradient; it depends only on the earth's stress field. (3) Fluid pressure gradient is dependent on fracture gradient. (4) Most abnormal fluid pressure systems may be pressured to the fracture gradient at their structurally highest point. 18 refs.

11604 Improving the accuracy of prognosing oil—gas productivity. Babaev, A.G. *Dokl. Akad. Nauk Uzb. SSR;* No. 1, 43-45(1976). (In Russian).

It is convenient to separate the whole problem of prognosis into conclusions of the regional and operative character. The regional prognosis is based on finding gas and oil from (1) a set of informative signs formulated with respect to lithologic-paleogeographic, tectonic, geochemical, hydrogeologic and bituminologic studies, (2) the most likely cross-sections where oil is to be found, (3) the regional structural indications of where oil is to be found, and (4) a general scheme of exploring the area. The operative prognosis requires justifying the initial criteria for reliability of the individual structural traps in a successful search for oil, finding new criteria, and justifying the oil drilling site. This separation of prognoses is rational in defining and limiting the areas of studies that are required. (SJR)

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 11603, 12613, 12987, 12988, 12989, 12990, 12991, 12993, 12995, 12998, 13002, 13185

11605 (BERC—0003-25) El Dorado micellar polymer project. Technical letter for July, 1977. (Cities Service Oil Co., Tulsa, Okla. (USA)). 1977. Contract EY-76-C-02-4100. 6p. Dep. NTIS, PC A02/MF A01.

Activities during the report period are summarized. Preflush injection in the Chesney Pattern averaged 1535 barrels per day at 190 psi plant pressure during the month of July. Combined micellar water and micellar oil injection in the Hegberg pattern was 75.6 barrels per day during July. Distomaceous earth filtration was set up in efforts to improve filterability of Hegberg soluble oil. Acid treatments were performed on four injection wells in the Hegberg pattern. The selection of polymer and low equivalent weight sulfonate to be used in the Chesney Pattern was completed.

11606 (BERC/TPR—77/4) Electrodril system field test program: phase I. Final report, May—December 1976. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). Oct 1977. Contract EY-76-C-02-4033. 100p. Dep. NTIS, PC A05/MF A01.

Phase 1 of the Electrodril System Field Test Program was set up to establish the technical viability of two Electrodril System configurations, the Directional Drilling System and the Major Drilling System. Both Electrodril configurations consist of an electric drill motor located directly above the bit, a downhole telemetry-control instrument designed to monitor hole position and other downhole parameters while drilling; a cable deployed through the drill string and remotely mated to the motor/instrument downhole in drilling mud and associated power conversion, cable handling, and data processing equipment on the surface. The Directional Drilling System used a 60HP drill motor, small $^3/_4$ in. diameter downhole cable connectors, and a "Yo-Yo" type cable deployment system. It is designed to drill deviated holes to depths of 10,000 feet or less. The Major Drilling System used a 285HP drill motor, large 1 in. diameter downhole cable connectors, cable suspended in the drill pipe by a special sub, pre-wired pipes, and slip rings. It is designed for deep, tough drilling under hostile conditions. Both configurations were shown to be compatible with existing rig equipment and procedures. A deviated hole was drilled using the Directional Drilling System with a bent sub. A straight hole was drilled through a concrete plug set in a cased well using the Major Drilling System. The Downhole Telemetry/Command instrument was used to monitor hole position, temperature, downhole voltage, and vibration while drilling. The Field Test did establish the technical viability of the Electrodril System.

11607 (ORO—8036-5) Pulse test analysis of vertically fractured wells. Final report, February 1, 1976—June 30, 1977. Raghavan, R. (Tulsa Univ., Okla. (USA)). 1977. Contract EY-76-S-21-8036. 214p. Dep. NTIS, PC A10/MF A01.

Thesis.

The orientation of vertical fractures has become a point of serious concern principally due to the implementation of newer and costlier chemical methods of fluid injection to enhance oil recovery. Several methods have been proposed in the literature to determine fracture orientation. These include the use of inflatable impression packers and television cameras, core analysis, geophysical techniques, and pressure transient analysis. The first three methods sample only a small volume of the reservoir and thus do not necessarily reflect conditions at some distance from the wellbore. Pressure transient tests may be used to sample a larger portion of the reservoir volume. Generalized correlations are presented whereby an engineer may easily analyze and/or design pulse tests in fractured wells from pulse tests. The results of the study can be used to obtain the compass orientation of a vertical fracture as well as the degree of reservoir anisotropy by pulse tests provided the formation permeability and fracture half-length are known. These two parameters may be easily obtained from a pressure test at the fractured well by type curve matching. This pressure test may be conducted subsequent to the pulse test or during the pulse test. If the formation permeability is known, then the results may be used to determine fracture half-length and compass orientation. Procedures to obtain the desired results are discussed in an example. The results can also be used to design pulse tests. Conditions necessary to insure that the response obtained is maximum are described. Thus, appropriate instruments, pulse periods, shut-in periods, etc. can be chosen to insure that the test is a success.

11608 (SAN/1395—9) Pilot demonstration of enhanced oil recovery by micellar polymer waterflooding: phase A. Quarterly report for the 1st quarter 1977. Wade, J.E.; Staub, H.L. (City of Long Beach, Calif. (USA)). 15 Apr 1977. Contract EF-77-C-03-1395. 62p. Dep. NTIS, PC A04/MF A01.

A micellar-polymer tertiary waterflood project is underway in the HXa sand, Fault Block VB, Wilmington Oil Field. All tasks in Phase A, with the exception of Task No. 5, have been successfully finalized. Because Task No. 5, sulfonation of a Wilmington crude feedstock, was an integral part of the subjects to be resolved under Phase A, Decision Point No. 1 must be delayed several months. Marathon was unable to schedule sulfonation of Wilmington feedstocks but is now conducting bench sulfonation of Wilmington feedstocks and has called upon Witco and Stepan to prepare Wilmington sulfonates in their pilot plants. Flood tests and polymer adsorbtion-degradation tests were performed on old core material from the Upper Terminal sand need to be repeated on fresh core samples from the well to be drilled for the mini-injectivity test. (DLC)

11609 (SAND—77-1644) Materials problems in thermal, enhanced oil recovery processes. Traeger, R.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 12p. Dep. NTIS, PC A02/MF A01.

Material limitations in the steam flooding and in situ combustion tertiary oil recovery processes were reviewed in a one day workshop. Material development needs for enhanced oil recovery include coatings for use at 400 to 700°F in wellbores, flexible materials for packers and electrical insulators for use above 300°F and metals for use in high temperature, HCl-H_2S environments. Since corrosion problems due to high temperatures and H_2S are also

experienced in other fossil fuel areas, material studies for oil recovery processes would be of benefit to these applications and should be closely coordinated with other research programs.

11610 Present state and ways to improve the development of the katur-tepe field. Ashirmamedov, M.A.; Peshkov, O.N.; Bychkov, A.I. (Turkm SSR Pet). *Geol. Nefti Gaza;* No. 5, 28-34(May 1977). (In Russian).

The Katur-Tepe oil and gas field in Turkmenia consists of 5 separate sectors. It began to be developed in 1969. Characteristics of each sector are given and ways to improve their yields are discussed.

11611 Technological water supply of oil fields from the well field at Dubrovcak. Deskin, M.; Zgaga, M. *Nafta (Zagreb);* **28**: No. 5, 294-304(May 1977). (In Serbo-Croatian).

The intake of underground water at Dubrovcak, Yugoslavia, provides 9,000 m^3 of technological water per day. This water is being injected into the oil fields Ivanic and Zutica. The intake is performed by wells with asbestos-cement well pipes and well screens. Despite a rather unfavorable chemical composition of this underground water, its processing and preparation for injection into the two oil fields proved considerably more convenient than the previous method of using water from the Sava river. Investigations to determine the best way of using this underground water are detailed. 14 refs.

11612 Conditions for rational development of oil fields in the North of Timan-Pechora oil and gas province. Musin, M.K.; Vasil'ev, I.P.; Khalimov, E.M. *Geol. Nefti Gaza;* No. 5, 20-27(May 1977). (In Russian).

Starting from the specific structure of the productive strata and oil pools of a number of deposits in the North of the Timan-Pechora oil and gas province, on the one hand, and from the experience of the development of some deposits in the Urals-Volga province, on the other, the most rational ways and methods of oil extraction from the new deposits of the area in question are recommended. In particular, application of intensive flooding methods is advocated. 10 refs.

11613 Transient pressure surges due to pipe movement in an oil well. Lubinski, A.; Hsu, F.H.; Nolte, K.G. (Amoco Prod Co). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 3, 307-347(May-Jun 1977).

A pressure surge which could cause lost circulation, results from running a stand of drill pipe or a joint of casing into a hole. Similarly, a negative pressure surge, which could cause a blowout, results from pulling pipe from a hole. In past investigations, pressure surges were calculated on the basis of steady state flow. It is shown that this led to erroneous results. In this investigation, pressure surges are calculated on the basis of transient wave propagation phenomena. A computer program is developed to that effect. Results of calculations and the mathematics are presented. 15 refs.

11614 Constructing micromodels for the study of multiphase flow in porous media. Bonnet, J.; Lenormand, R. (Groupe d'Etud IFP-IMF sur les Milieux Poreux, Fr). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 3, 477-480(May-Jun 1977). (In French).

New method of modelling with polyester resin is proposed to avoid inconveniences experienced with other micromodels. 6 refs.

11615 Thermal recovery in the Venezuelan heavy oil belt. Ballard, J.R.; Lanfranchi, E.E.; Vangs, P.A. (Amoco Int Oil Co, Chicago, Ill). *J. Can. Pet. Technol.;* **16**: No. 2, 22-27(Apr-Jun 1977).

This paper describes a successful cyclic steam injection program in the Jobo Field, located on the northeastern edge of the Venezuelan Heavy Oil Belt. The program was commenced in 1974 by Amoco International Oil Company. It is being continued, following reversion, by Amoven, S.A., a subsidiary of Petroleos de Venezuela. The techniques described here have permitted injection of high-quality steam at appreciable depths while avoiding most of the common problems normally expected, such as bottom-hole equipment failures, casing cement and liner failures, and surface equipment malfunctions.

11616 Overpressure detection and control at Imp Immerk B-48 using a wellsite mud gas detector. Daw, R.N.; Mercer, R.F.; Myers, D.L. (Imp Oil Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 2, 28-33(Apr-Jun 1977).

Continuous mud gas detection was used at Imp Immerk B-48 in the Mackenzie Delta during drilling operations to assist in the detection and control of overpressure due to undercompaction of fine-grained sediments. Special techniques used in conjunction with the gas detector data improved the ability to relate the increase in formation pore pressure to the required mud weight as drilling proceeded. Careful interpretation of the mud gas response to the drilling actions showed a repetitive cycle of events. Knowing the cause of these repetitive cycles and recognizing current position in the cycle increased drilling safety by providing better control of mud weight. 4 refs.

11617 Pool description and performance analysis leads to understanding Golden Spike's miscible flood. Reitzel, G.A.; Callow, G.O. (Imp Oil Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 2, 39-48(Apr-Jun 1977).

Reservoir description was a key factor in analyzing the performance of the Golden Spike vertical gravity-controlled miscible L.P.G. (liquefied petroleum gas) bank scheme. Understanding the performance of the pool was enhanced by including a detailed reservoir description in a computer model study of the miscible scheme. The originally designed 7% pore volume L.P.G. bank was injected between the gas and oil zones from 1964 through 1975. The cross-section model indicates that the vertical flow barriers combined with the designed bank size results in poor sweep efficiency by solvent. However, future sweep efficiency by gas is predicted to be high due to continued drainage of oil off the barriers. 7 refs.

11618 Performance simulation of the Snipe Lake Beaverhill Lake a pool--a geologically complex reservoir. Lang, R.V. (Gulf Oil Can Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 2, 68-90(Apr-Jun 1977).

This paper illustrates the inter-relationship of geology and reservoir engineering in reservoir simulation. A three-phase three-dimensional, unsteady-state model study was undertaken to resolve the complex pressure and production characteristics of the Snipe Lake Beaverhill Lake A Pool in Alberta and to allow meaningful predictions of future performance. The study began with a detailed investigation of the geology of the pool to allow the definition and generation of the basic model data input. Additional studies of the production, perforation and pressure histories of the wells, taking into account the layering concepts developed in the geological study, helped to indicate broad performance concepts. 2 refs.

11619 Polymer flow behavior as applied to enhanced recovery. Stanislav, J.F.; Kabir, C.S. (Univ of Calgary, Alberta). *J. Can. Pet. Technol.;* **16**: No. 2, 91-97(Apr-Jun 1977).

Polymer solution flow behavior through porous media has been studied at length over the last decade with a view to improve oil recovery. An attempt has been made in this paper to understand the basic flow behavior mechanisms involved, along with pertinent aspects. Numerous field results are also summarized which reveal how flood success or failure is dependent on reservoir and fluid characteristics. Refs.

11620 Offshore platform. Robert, H.; Kalthoff, D. (to Hochtief A.G., Essen (Germany, F.R.)). German(FRG) Patent 2,535,384/A/. 10 Feb 1977. 10p. (In German).

Subject of the invention is an off-shore platform with foundation body, connected supporting structure, and platform floor. The foundation body contains storage cavities for storing petroleum and consists of reinforced concrete. The storage cavities are designed as individual container components and joined to the foundation body through the intermediary of expansion joints, in order that no contraints will arise any longer if hot petroleum is filled into the storage cavities. Details of the construction are the subject of the patent claims.

11621 Depositional environment of clastics and its application in oil field development. Perez M, J.D. (Inst Mex del Pet). *Rev. Inst. Mex. Pet.;* **9**: No. 1, 30-46(Jan 1977). (In Spanish).

The importance of the understanding of the depositional environments for the development of oil fields is pointed out. A method is proposed which makes it possible to recognize these environments from geophysical well log data. The advantages of combining structural and stratigraphic aspects in oil field development to achieve improved accuracy in oil well localization are analyzed. 13 refs.

11622 Optimal control of dynamic processes of irrigation of oil field. Litvak, B.L.; Litvak, M.L.; Meerov, M.V. *Autom. Remote Control (USSR) (Engl. Transl.);* **38**: No. 1, 58-68(Jan 1977).

The problem is considered of finding optimal modes of operation of oil fields with account taken of the dynamic processes of irrigation, beginning with the condition of optimization of the ultimate oil yield over the operating period. The vein is described by a nonlinear system of partial differential equations. A method is proposed for solution, this being the numerical realization of the maximum principle, wherein the original dynamic problem is decomposed into a sequence of special static problems for the individual moments of time. The underpinnings of the method are provided, as well as the proof of convergence when use is made of the requisite conditions of optimality. 8 refs.

11623 Method for the complete or partial removal of straight-chained hydrocarbons from petroleum fractions. Champagnat, A. (to British Petroleum Co., Ltd., London). German(FRG) Patent 1,470,484/C/. 9 Dec 1976. 4p. (In German).

In the method proposed here, a special yeast strain able to grow on straight-chained paraffinic hydrocarbons is used to partially or completely remove these hydrocarbons from petroleum fractions

which, in addition to isoparaffines, naphthenes, and aromates, may contain 3 to 45 weight % of straight-chained hydrocarbons and have a mean molecular weight of at least 10 C atoms. The yeast is grown at 25 to 30° in a fermentation liquor containing nutritional solution and the finely dispersed hydrocarbon fraction, through which a gas flow containing free oxygen is led in the form of fine bubbles. The pH value is kept at a value of 4 to 5. The yeast strain is grown until the setting point of the petroleum fraction has been lowered ot the desired value. The emulsion of yeast, aqueous nutritional medium, and liquid hydrocarbons, is broken up by centrifugation in the presence of a surfactant; after this, fine purification of the separated phase ensues.

11624 Method for producing hydrocarbons from an underground formation. Carlin, J.T.; Cardenas, R.L. (to Texaco Development Corp., New York (USA)). German(FRG) Patent 2,450,290/C/. 18 Nov 1976. 5p. (In German).

The invention refers to a secondary resp. tertiary production method for petroleum from underground formations. It was found that in the presence of saline water the emulsification of crude oil can be carried out by injecting an amount containing secondary unsaturated alcohol, i.e. cholesterol, and by subsequent injecting of saline water containing fat alcohol, i.e. Na-dodecylsulfate. The invention is explained in detail by means of diagrams, presenting the displacement of capillary oil in dependence of the compounds utilized.

11625 Surface-active mixture for the flooding of subterraneous petroleum deposits. Plummer, M.A.; Roszelle, W.O. (to Marathon Oil Co., Findlay, Ohio (USA)). German(FRG) Patent 2,430,935/B/. 18 Nov 1976. 3p. (In German).

A surfactant mixture for flooding underground petroleum deposits is described, consisting of at least one hydrocarbon, two different petroleum sulfonates, and an aqueous medium. The mixture is characterized in that the petroleum sulfonates have an average equivalent weight between 390 and 450 and an aliphatic-aromatic proton ratio between 4 and 20:1, this ratio varying between the individual sulfonates by at least 2.5:1. Further characterizing features are given by the subclaims. Examples of application are given.

11626 Two-dimensional problems of displacement in the case of nonlinear filtration laws. Zaidel, Ya.M.; Levi, B.I.; Shakhmaeva, A.G. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 5, 710-714(Sep-Oct 1976).

A method is proposed for calculation the multidimensional displacement of oil possessing anomalous properties from productive strata by water. Numerical solutions are obtained on the basis of the most generally accepted models of non-Newtonian oil within the framework of the theory of two-phase filtration of immiscible liquids. 11 refs.

11627 Offshore drilling rig. Pogonowski, I.C.; Carmichael, P.D. (to Texaco Development Corp., New York (USA)). German(FRG) Patent 2,439,576/A/. 6 Mar 1975. 17p. (In German).

An offshore dirlling rig is described which is provided with a heavy concrete foundation plate on the seabed. This foundation plate includes the lower end of the drilling rig and forms an additional weighting and this increases the stability of the whole drilling rig. As the foundation plate is arranged around the supporting legs of the drilling rig, the washing away of the supporting legs by ocean currents is avoided. (HR) .

PROCESSING

REFER ALSO TO CITATION(S) 12884

11628 Method for the treatment of heavy petroleum oil. Seguchi, K.; Sugita, M.; Inada, K.; Tagaya, K.; Nakamura, Y. (to Kureha Kagaku Kogyo Kabushiki Kaisha). US Patent 4,046,670. 6 Sep 1977. Priority date 30 Apr 1975, Japan. 14p.

In the thermal cracking of heavy petroleum oil (having an API specific gravity of not more than 25) in a tubular type heating furnace, a specific inorganic substance is added in a specific proportion to the heavy petroleum oil to prevent the heavy oil from undergoing coking inside the furnace.

11629 Method for the treatment of heavy petroleum oil. Seguchi, K.; Sugita, M.; Inada, K.; Tagaya, K.; Nakamura, Y. (to Kureha Kagako Kogyo Kabushiki Kaisha). US Patent 4,042,487. 16 Aug 1977. Priority date 8 May 1975, Japan. 8p.

In the thermal cracking of a heavy petroleum oil (having an API specific gravity of not more than 25) in a tubular type heating furnace, possible occurrence of coking trouble inside the furnace can be prevented by applying a magnetic field of fixed magnitude transversely to the flow of the heavy petroleum oil being introduced into the furnace or by applying a fixed magnitude of magnetic field transversely and, at the same time, applying a fixed magnitude of direct-current voltage parallel to the flow of the heavy petroleum oil being introduced into the furnace. More effective prevention of occurrence of coking can be obtained by having a specific inorganic substance incorporated in the heavy petroleum oil before the oil is subjected to the magnetic field or to simultaneous application of the magnetic field and voltage.

11630 Low temperature units interfacing with chemical or metallurgical overall processes. Linde, G. *Verfahrenstechnik (Mainz);* **11**: No. 6, 342, 344, 346(Jun 1977). (In German).

Technical gas separation units as raw material suppliers for other industrial processes are discussed using examples of an olefin and fertilizer plant. Aspects of gas purity and economicality of opeerations are considered in both natural gas and heavy fuel oil refining. 3 refs.

11631 Effect of rheonyl 1500 addition to deparaffinate on activity of catalysts of hydrorefining of lubrication oils. Kajdas, C.; Czerwiec, W. (Politech Swietokryzyska w Kielcach, Pol). *Przem. Chem.;* **56**: No. 6, 310-312(Jun 1977). (In Polish).

Presentation is made of further results of studies concerning complex modernization of technology of producing lubricating base oils. It has been established that the presence of rheonyl 1500 in deparaffinate does not affect negatively the catalysts; on the contrary, under definite conditions it improves its hydroisomerizing properties. The resistance of cobalt--molybdenum catalysts against rheonyl 1500 activity has been confirmed on industrial scale within the period of over one year in the hydrorefining installation for lubrication oils. 2 refs.

11632 Development of process for producing acetylene by partial oxidation of hydrocarbons. Batholome, E. *Chem.-Ing.-Tech.;* **49**: No. 6, 459-463(Jun 1977). (In German with English abstract).

The very first industrial plant for generating acetylene by partial oxidation of hydrocarbons demonstrated the technical reliability and satisfactory economics of the BASF process. The ensuing 15 years saw a lively development in the construction of new large-scale acetylene plant employing this process. This development came to a halt at the end of the 1960's. The real reason may be seen in the increasing success achieved in producing the principal reaction products of acetylene from cheaper raw materials, especially olefins. 21 refs.

11633 Modification of the process of deparaffination of furfurol raffinate. Czerwiec, W.; Kajdas, C. (Politech Swietokrzyska, Cracow, Pol). *Przem. Chem.;* **56**: No. 5, 237-239(May 1977). (In Polish).

Presentation is made of results of laboratory and industrial investigations concerning a modification of the process of deparaffination of oily furfurol raffinates by means of an addition of reonyl 1500. It has been established that the application of this crystallization modifier makes possible a rise in the yield of deparaffinates, an increase of the filter capacity and a diminution of oil content in slack waxes with a simultaneous improvement of quality of products obtained. 19 refs.

11634 Some trends in testing of industrial platforming catalysts under laboratory conditions. Selakovic, O.; Jovanovic, M. *Nafta (Zagreb);* **28**: No. 4, 207-210(Apr 1977). (In Serbo-Croatian).

Laboratory test methods for industrial platinum catalysts used in the gasoline platforming process are presented. These methods are employed to determine active metal surface, dispersion of metal component, surface area and porous structure in order to establish the aging process in a multi-functional platinum catalyst. In this work, laboratory results obtained with the help of such test methods on both new and used catalyst specimens are compared. 18 refs.

11635 Extraction of aromatic hydrocarbons from heavy oil (Benicanci crude oil) by furfural and dimethyl sulfoxide. Malikovic, D.; Malikovic, D.; Meles, S.; Paulin, S. (INA-Refinerije Nafte, Sisek, Yugosl). *Nafta (Zagreb);* **28**: No. 4, 213-222(Apr 1977). (In Serbo-Croatian).

Laboratory tests were conducted on the extraction of aromatic hydrocarbons from mixtures of light and heavy vacuum gas oil (feedstock for catalytic cracking--Benicanci crude), using furfural and dimethyl sulfoxide for extraction at temperatures of 40°C and 60°C. Different extraction phase ratios were employed (1:1, 2:1, 3:1, 4:1). The concentration of aromatics was measured by the refractometric method. The effect of extraction phase ratio on the extraction factor and the change of aromatic hydrocarbons content in raffinate during multiple extraction were determined. 77 refs.

11636 Desulphurization and cracking of de-asphalted petroleum residues. Lorenz, E. (BASF A.G., Ludwigshafen am Rhein (Germany, F.R.)); Billon, A. (Institut Francais du Petrole (IFP), 69 - Solaize). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 2, 90(Feb 1977). (In German).

For the treatment of the vacuum residues to give asphalt-free oils containing little metal which can be treated further in a similar way as vacuum distillates with well-tried methods, de-asphalting

with solvents is particularly suitable. By using paraffin hydrocarbons of different molecular weight as solvents and by variation of the extraction temperature, oil yield and the characteristics of oil can be influenced within a relatively wide range. For the desulfurization of residual oils on solid-bed-catalysts, the indirect way via vacuum distillation, de-asphaltization of the residual oil, hydrogenating desulfurization of vacuum distillates and de-asphalted oil is in many cases of advantage compared with direct desulfurization of oil. De-asphalting with several solvents is shown in a table.

11637 Stress corrosion cracks in the inner lining of a hydrodesulfurization plant reactor. Gonzalez T, R.; Loyo M, H. (Inst Mex del Pet). *Rev. Inst. Mex. Pet.;* **9**: No. 1, 76-84(Jan 1977). (In Spanish).

The stress corrosion cracking phenomenon is discussed by the example of the inner lining of a hydrodesulfurization plant reactor, made of type AISI 321 stainless steel, in which cracks frequently occur. Some suggestions are given to diminish or eliminate the problem. 5 refs.

11638 Stability of autothermic reactors for oxidative cracking of hydrocarbons. Henkel, H.J. (Siemens A.G., Erlangen (Germany, F.R.). Forschungslaboratorium). *Siemens Forsch.- Entwicklungsber.;* **6**: No. 2, 74-77(1977). (In German).

The stability of an adiabatic reactor during exothermal reaction, experimental investigations concerning the oxidative cracking of hydrocarbons with little air supply, as well as consequences are described.

11639 Methods of regeneration of waste liquor from olefin plants. Baur, K. *Linde Rep. Sci. Technol.;* No. 25, 46-49(1977).

Several methods of removing, processing and eliminating the waste liquor from olefin plants are described, including the liquor scrubbing process, waste liquor oxidation by means of air, and waste-liquor neutralization and stripping. While the selection of any of the described processes for waste liquor removal depends on the specific requirements of individual olefin plants, all of these processes ensure that the public waters are not polluted by poisonous substances. 5 refs.

11640 Method for the conversion of hydrocarbon charges. Whittam, T.V. (to Imperial Chemical Industries Ltd., London (UK)). German(FRG) Patent 2,618,689/A/. 11 Nov 1976. 23p. (In German).

The basis of the invention is the application of defined zeolites as catalysts to hydrocarbon conversion processes such as reformation, isomerization, dehydrocyclization, and cracking. By charging the zeolite carrier masses with 0.001 to 5% metal of the 8th group of the periodic system, preferably noble metals, a wide region of applications for the catalysts is achieved. A method for the isomerization of an alkyl benzene (or mixture of alkyl benzenes) in the liquid or gas phase under suitable temperature, pressure and flow-rate conditions, as well as in the presence of a cyclic hydrocarbon, is described as preferential model form of the invention; furthermore, a method for the reformation of a hydrocarbon fraction boiling in the gasoline or benzene boiling region and a method for the hydrocracking of hydrocarbon charge (e.g. naphtha, kerosine, gas oils) are given. Types of performance of the methods are explained using various examples.

11641 Process for the catalytic refining of petroleum distillates containing organic sulfur compounds and of gaseous hydrocarbons by steam conversion. von Kessel, K.; Deringer, H.; Radusch, P. (to Krupp-Koppers G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 1,470,588/C/. 4 Nov 1976. 3p. (In German).

A catalytic refining process for petroleum distillates and gaseous hydrocarbons containing organic sulfur compounds is claimed. Compared to known processes, it has the advantage that apart from the initial hydrocarbons, it works on steam alone, independently of the content of naphthenes and sulfur compounds. Furhtermore, the purification stage otherwise used for the removal of the H_2S formed can be dispensed with. According to the process described here, the vaporous initial product, in a 1:1 resp. 1:2 mixture with steam, is converted on a high-activity, nickel-containing catalyst at temperatures of 250 to 450°C, pressures of 1 to 40 atmoshperic excess pressure, and a velocity of flow of 200:1 to 500:1. The catalyst itself acts as absorption mass for the H_2S formed and may be regenerated after it has been completely exhausted. The process is carried out in two identical refinery stages connected in series.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 11457, 11631, 11634, 12614

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11809

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11673, 12612, 12616

11642 (NP—22603) Cost of finding, developing, and producing crude oil in the United States. (Nathan (Robert R.) Associates, Inc., Washington, D.C. (USA)). 28 Apr 1975. vp. R. Nathan Associates, Inc., Washington, DC.

Analysis shows that it costs a great deal more to find, develop, and produce oil today than ever in the past. If this nation is serious about reducing dependence on oil imported from insecure sources, it will have to pay sufficient prices to cover the true economic costs of exploration, discovery, development, and production. 7 charts.

11643 Leasing: an alternative source of finance. *Pet. Rev.;* **31**: No. 366, 3,5(Jun 1977).

Leasing is now an important source of corporate financing in the United Kingdom. A financial lease differs from an operating lease in that the lease period covers the whole of the life of the asset: the lessor will get his return without any risk of being unable to release the asset. Tax advantages of leasing are illustrated with reference to Anaconda's arrangements concerning an aluminum-reduction mill and Lindsey Oil Refinery's arrangement for leasing a catcracker extension to its refinery.

11644 West German petroleum industry 1976. *Oel;* **15**: No. 5, 136-139(May 1977). (In German).

The article presents a survey of the petroleum industry 1976 in the FRG. Information in tabular form is presented on: 1. Crude oil production in the FRG, 2. natural gas production in the FRG, 3. crude oil imports according to countries of origin, 4. refinery capacities, 5. overall petroleum demand and meeting this demand, 6. production of petroleum products in refineries, 7. importations and the GDR's share, 8. petroleum consumption, 9. gasoline, 10. heating oil production, 11. bitumen production, 12. lubricant production.

11645 Petroleum market and supplier structures: pleading for the protection of elements of the free enterprise system. Schuermann, H.J. (Koeln Univ. (Germany, F.R.). Energiewirtschaftliches Inst.). *Oel;* **15**: No. 3, 68-73(Mar 1977). (In German).

A thorough investigation of the competition situation in the German petroleum market reveals that in this industry the conditions allowing fair competition continue to exist and suggests that, therefore, the economic policy of the government agencies should encourage the forces supporting free competition.

WASTE MANAGEMENT

11646 Flotation in combination with ozone enrichment for the cleaning of refinery waste waters and for the removal of dissolved organic substances. Dietrich, K.R. *Gesund.-Ing.;* **97**: No. 9, 209-211(Sep 1976). (In German).

Oil removal from liquid refinery wastes by intensified flocculation and precipitation in the course of the flotation process causes only a slight reduction of the oxygen demand of the sedimented waste waters; the oxygen demand is measured as CSB (chemischer Sauerstoffbedarf). The present paper deals with CSB reduction by chemical-mechanical oil removal rather than with improvements on the flotation process. The required CSB reduction can be achieved by ozone treatment in a subsequent stage. This processing technology is important under the aspect of the new waste water discharge law soon to be issued.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 11639, 11653, 11656, 11657, 11658, 13062, 13184

11647 Systems of monitoring and controlling hydrocarbon discharges: olemeters. Guigues, F. (Guigues S.A.). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 3, 349-366(May-Jun 1977). (In French).

The choice of equipment for titrating the amount of hydrocarbons in water discharged into the sea must necessarily be suitably adapted to the goal aimed at. The specifications for such equipment include ten main features: (1) Measuring range: 0 to 100 ppm of hydrocarbons (possibility of going to 1,000 ppm); (2) Measurement

frequency: continuous sampling and analysis equipment; (3) Hydrocarbon quality: at present, heavy hydrocarbons, and future adaptability to refined products; (4) Respect for analysis specifications: physical measurement falling outside of specifications on account of the importance of making fast measurements; (5) Automatic constant-sampling device: response time less than 40 seconds; (6) Respect for "intrinsic safety" conditions; (7) Equipment using no auxiliary solvent (to respect response time); (8) Measurement accuracy: +-10% of the entire measurement range; (9) Maintenance: reduced it is almost simplicity; (10) Possibility of connecting a "black box" for making a posteriori checks. The article describes various types of equipment on detecting the hydrocarbons contained in tanker deballasting water. The Ultra-Rapid Response Detector (DRUR) is examined in particular detail because it meets the ten conditions listed above. The laboratory results obtained in control loops have now been confirmed by those obtained with tankers in service.

11648 Soil restoration following oil spills: a review. McGill, W.B. (Univ of Alberta, Edmonton). *J. Can. Pet. Technol.;* **16**: No. 2, 60-67(Apr-Jun 1977).

An average of 1-2 oil spills occur in Alberta per day. Most of these are on land. Although many studies have been conducted into the effects of oil on plants and water, only a limited number have dealt with soil. This paper summarizes the information on soil restoration following oil spills. The development of an understanding of oil spill effects on soil is reviewed together with the early literature examining site restoration. Recent restoration research is dealt with in detail and the advantages of various techniques are discussed. Non-biological mechanisms of oil removal from soil, such as volatilization, burning and photodecomposition, are examined first, followed by biological restoration procedures. 57 refs.

11649 Evolution of paraffinic and naphtenic hydrocarbon and 3,4 benzopyrene content in mussels from a coastal zone polluted by a fuel spill. Bories, G.; Tulliez, J.; Peltier, J.C.; Fleckinger, R. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **282**: No. 17, 1641-1644(3 May 1969). (In French).

After an oil spill, a coastal zone was polluted and wild mussels were contaminated by paraffinic and naphtenic hydrocarbons and 3,4-benzopyrene. The evolution of this contamination was followed. Normal levels were re-established after a month and a half. Normal paraffins were metabolized faster than other hydrocarbons.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 12596, 12612, 12615, 12616

11650 UN and petroleum in 1976. Heller, C.A. *Pet. Rev.;* **31**: No. 366, 7,9(Jun 1977).

The UN's thirty-first session is reviewed with regard to petroleum-related matters. Items covered include the exploitation of the deep sea outside the 200 mile zone and activities of the Centre of Natural Resources, Energy and Transport (CNRET).

TRANSPORT, PIPELINES, AND HANDLING

11651 Pipes for gas and oil pipelines with continuous compensator of axial deformation. Raevskii, G.V.; Los, A.O.; Ivantsov, O.M. (Weld Inst im. E.O. Paton, Acad of Sci of the Ukr SSR). *Avtomat. Svarka;* No. 2, 16-19(Feb 1977). (In Russian).

Results of development and investigation of a new design of pipes for major pipelines operating in conditions of considerable temperature fluctuations are presented. Thanks to corrugations along a spiral line, continuous compensation of axial deformations of the pipeline due to changes in temperature, internal pressure, and other factors, is ensured.

PROPERTIES

REFER ALSO TO CITATION(S) 11614, 11696

11652 (BERC/PPS—77/5) Diesel fuel oils, 1977. Shelton, E.M. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Nov 1977. 37p. Dep. NTIS, PC A03/MF A01.

Properties of diesel fuels produced during 1977 were submitted for study and compilation under a cooperative agreement between the Department of Energy (DOE), Bartlesville Energy Research Center (BERC), Bartlesville, Oklahoma and the American Petroleum Institute (API). Tests of 215 samples of diesel fuel oils from 100 refineries throughout the country were made by 31 petroleum refining companies. The analyses of the fuels are listed in tables for four groups according to type to diesel fuel. Each group of analyses is subdivided into five tabulations according to five general regions of the country where the fuels are marketed. The regions, containing a total of 16 districts, are shown on a map in the report. A total of 13 laboratory tests are listed and arranged by geographic marketing districts in decreasing order of sales volumes. Charts are included showing trends of averages of certain properties for the four types of diesel fuels for the years 1960-1977. Summaries of the results of the 1977 survey, compared with similar data for 1976, are shown in tables.

11653 Fluorescence method for the measurement of the partition coefficients of naphthalene, 1-methylnaphthalene, and 1-ethylnaphthalene in water. Schwarz, F.P.; Wasik, S.P. (NBS, Washington, DC). *J. Chem. Eng. Data;* **22**: No. 3, 270-273(Jul 1977).

A method is described for the determination of the partition coefficients of aromatic hydrocarbons in water by fluorescence measurements. The partition coefficients of water solutions of naphthalene, 1-methylnaphthalene, and 1-ethylnaphthalene between 8 and 31 C were determined by this method. The solubilities of naphthalene in water over this temperature range were calculated from its partition coefficients. This work has application to the removal of aromatic hydrocarbon components of oil spills in the ocean. 17 refs.

11654 Titrating arsenic in catalytic reforming feedstocks by flameless atomic absorption. La Villa, F.; Queraud, F. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 3, 413-426(May-Jun 1977). (In French with English abstract).

After the sample has been treated by an iodine solution in toluene, the arsenic is extracted by diluted nitric acid. Magnesium nitrate is added so as to make the extracted arsenic less volatile. This method is capable of attaining a detection limit of one microgram per liter. It can be applied to types of naphthas other than catalytic reforming feedstocks. 10 refs.

11655 Stability of concentrated crude oil-in-water emulsions as a function of shear rate, temperature and oil concentration. Mao, M.M.; Marsden, S.S. (Stanford Univ, Calif). *J. Can. Pet. Technol.;* **16**: No. 2, 54-59(Apr-Jun 1977).

Emulsions were prepared with a California crude oil and tap water by stabilizing with a nonionic emulsifier (Triton X-114). Their rheological properties were studied as a function of composition, temperature and shear rate. Those having high concentrations of the dispersed phase behaved like pseudoplastic fluids. Apparent viscosity or consistency increased with the concentration of the dispersed phase and decreased with temperature. ASTM plots of kinematic viscosity vs temperature were linear for each emulsion. Viscosity corrections for temperature could be made for the W/O emulsions, but not the O/W ones, from a knowledge of the viscosity-temperature relationship for the oil and a single value of the emulsion's apparent viscosity. 12 refs.

STORAGE

11656 (FEA/S—77/213) Strategic Petroleum Reserve: draft environmntal impact statement for Sulphur Mines Salt Dome. (Federal Energy Administration, Washington, D.C. (USA)). Sep 1977. 551p. (DES—77-6). Dep. NTIS, PC A24/MF A01.

This document is a site-specific environmental impact statement (EIS) for the proposed storage of 24 million barrels of crude oil at the Sulphur Mines salt dome located in Calcasieu Parish, Louisiana. Sulfur Mines is a candidate site for the Strategic Petroleum Reserve (SPR) program currently being implemented by the Federal Energy Administration (FEA). Creation of the SPR was mandated by Congress in Title I, Part B of the Energy Policy and Conservation Act of 1975, P.L. 94-163 (the Act) for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any future oil-supply interruption.

11657 (FEA/S—77/228) Strategic Petroleum Reserve: Supplement to final environmental impact statements for Weeks Island/Cote Blanche Mines. (Federal Energy Administration, Washington, D.C. (USA)). Aug 1977. 256p. (FEA—7677-7; FES—76/77-8). Dep. NTIS, PC A12/MF A01.

FEA proposes to implement the Strategic Petroleum Reserve through the development of an 89 million barrel crude oil storage facility at the Weeks Island Mine (LA) and a 27 million barrel facility at the Cote Blanche Mine (LA). The oil transportation systems have been revised to provide direction connection by pipeline to the existing oil distribution system at St. James, LA. This site-specific EIS supplement analyzes the environmental impacts caused by site preparation and operation of the proposed St. James oil distribution system and compares these impacts with those of the barge distribution system considered in the Final EISs. (DLC)

11658 (FEA/S—77/329) Strategic Petroleum Reserve: draft supplement to the final environmental impact statement. (Federal Energy

Administration, Washington, D.C. (USA)). Sep 1977. 258p. (FES—76-2). Dep. NTIS, PC A12/MF A01.

The Federal Energy Administration proposes to implement the Strategic Petroleum Reserve, Title I, Part B of the Energy Policy and Conservation Act of 1975 (P.L. 94-163). The purpose of the Reserve is to mitigate the economic impacts of any future interruptions of petroleum imports. The impact of storing one hundred fifty million barrels (MMB) of oil by 1978 and five hundred MMB by 1982 was addressed in the final programmatic EIS and the SPR Plan. It is now proposed that the SPR be expanded to store a total of 1,000 MMB. This supplement addresses the environmental impact of this proposed expansion.

11659 Storage of energy carriers in offshore caverns. Dreyer, W. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.)). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 5, 205-210(May 1977). (In German).

On the basis of drilling activities on the mainland along the North Sea, knowledge gained in the field of onshore cavern techniques concerning the storage of liquid and gaseous energy carriers, and on the basis of some aspects concerning economy, this article deals with technical and mining pre-conditions which allow energy carriers to be stored in offshore areas. 5 figs., 9 refs..

COMBUSTION

REFER ALSO TO CITATION(S) 11579

11660 Additive and fuel mixture to prevent corrosion and ash deposition in plants operated with fossil fuel. Scott, J.F. (to Perolin Co., Inc., Wilton, Conn. (USA)). German(FRG) Patent 2,341,692/C/. 27 Jan 1977. 7p. (In German).

The patent claim refers to an additive to prevent corrosion and ash deposition in oils, steam boilers, diesel engines and gas turbines where fuel oils with ash content are used. The additive consists of a silicon and a magnesium compound. According to the invention, the ratio SiO_2:MgO is higher than 2:1. The magnesium compound is magnesium acetate, chloride, sulfonate, naphthenate, oleate or octoate, while the silicon compound is an organic silicon compound. At least 0.05 parts by weight of combined SiO_2 and MgO equivalent per part by weight of ash are added to the fuel. When using the fuel in gas turbines with vanadium and/or alkali metal as impurities, at least two parts by weight of magnesium per part by weight of vanadium and at least two parts by weight of silicon per part by weight of alkali metal are added to the fuel.

NATURAL GAS

REFER ALSO TO CITATION(S) 12628

RESERVES

REFER ALSO TO CITATION(S) 11502, 11612, 12618

11661 New developments in the North Sea. Ruch, S. *Sawyer's Gas Turbine Int.;* **18**: No. 4, 32-34(1977).

United technologies Power Systems Division, headquartered in Farmington, Connecticut, USA, has been selected by ELF-Norge A/S to supply three FT4 gas turbine compressor sets, to be installed by 1980 on Platform TCP-2 Frigg Field, in the North Sea. Frigg Field, located between the Norwegian coast and the Shetland Islands in the northern area of the North Sea, is eventually expected to supply up to 30% of the United Kingdom's gas requirements. Preliminary testing showed large outputs of sweet dry gas, approximately 95% methane and 4% ethane. The deposit was declared "commercial" in 1972. Workable reserves are now estimated at about 200 billion cubic meters, making Frigg Field the largest known offshore gas deposit.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 11602, 11604

11662 (MLM—2466(OP)) **Physicochemical characterization of Devonian gas shale.** Zielinski, R.E.; Attalla, A.; Stacy, E.; Craft, B.D.; Wise, R.L. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 24p. (CONF-771038—3). MN A01.

From Eastern gas shale program conference; Morgantown, WV, USA (17 Oct 1977).

Several physicochemical analyses are being performed to better characterize the Devonian gas shales located in the Appalachian and Illinois Basins. The results of these analyses are being integrated with the geochemical analyses to present an accurate characterization of the Devonian shales and to accurately assess their resource potential. These studies are also providing data that are being used to evaluate the physical behavior of the shales.

11663 (MLM—2467(OP)) **Geochemical characterization of Devonian gas shale.** Zielinski, R.E. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 24p. (CONF-771038—4). Dep. NTIS, PC A02/MF A01.

From Eastern gas shale program conference; Morgantown, WV, USA (17 Oct 1977).

Detailed geochemical analyses are being used to provide an accurate assessment of the oil and gas resources present in the Devonian shales in the Appalachian and Illinois Basins. The suite of geochemical analyses is designed to evaluate the organic richness, the hydrocarbon potential, the type of organic matter and the thermal maturity of the organic matter. Laboratory techniques such as pyrolysis gas chromatography and mass balance thermal extraction were also employed to measure thermally derived oil and gas yields from the Devonian shales. Stable carbon isotope geochemistry has also been initiated. The first phase of this study involved the determination of stable carbon isotope values for shale core samples.

11664 (MLM—2469(OP)) **Interactive data management and analysis system for the Eastern Gas Shale Program.** Seabaugh, P.W.; Zielinski, R.E. (Mound Lab., Miamisburg, Ohio (USA)). 1977. Contract EY-76-C-04-0053. 8p. (CONF-771038—5). MF A01.

From Eastern gas shale program conference; Morgantown, WV, USA (17 Oct 1977).

A versatile, easy-to-use data base system is described. The system provides flexibility in display formats as well as input and output options such as format compatibility adaptive to field data. Both on- and off-line capability exists. Versatility is attained through logical, boolean, ana arithmetic expressions. Consequently, computational capability is available so that data input can be minimized. Browsing and recursive searches are available through a search criteria command that allows the user to modify and narrow the request without restart. The system provides plotting options; data can be plotted in a well profile format. Through GEOLOG, a soft-wired synergistic log system, well log data can be integrated with geochemical and geophysical experimental data. This integration will provide a more accurate assessment of the resource potential of the well. Utilization of these features provides not only a fully interactive data management system but also an enhanced statistical capability for data analysis.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 11610, 11612, 11617, 11630, 12613, 12987, 12988, 12989, 12990, 12991, 12993, 12995, 12998, 13002, 13185

11665 Natural gas field: Westemsland. *Oel;* **15**: No. 6, 153-159(Jun 1977). (In German).

In spring the production of natural gas from the Westemsland topped the ten billion cubic meter mark. The report gives an outline of the history of this important hydrocarbon province and of the present situation of the production from the region.

11666 Construction and operation of the clenze nitrogen removal plant. Kaast, H.; Schlemm, F. (Brigitta und Elwerath Betriebsfuehrungsges, Hannover, Ger). *Erdoel-Erdgas Z.;* **93**: No. 6, 197-204(Jun 1977). (In German).

The recently discovered Wustrow natural gas field in the new gas province of Ost-Hannover in West Germany offers an unusual kind of gas: it has a high nitrogen content of 56-72% and a calorific value between 1,600 and 4,000 kcal/cm³ (760 Torr, 0°C), and cannot be shipped directly to the market in its existing form. This article describes construction and operation of a nitrogen separation plant that uses a low-temperature process in which liquid methane is removed and then converted into gaseous state through an evaporator.

11667 Method to remove sulfur compounds from gases consisting basically of methane and hydrogen. Dent, F.J. (to British Gas Corp., London). German(FRG) Patent 1,669,325/B/. 26 May 1976. 4p. (In German).

The article describes a method to remove sulfur compounds from gases consisting mainly of methane and hydrogen. According to this method, the gas is mixed with vapor and led through an absorbent at 300-400°C. Normally this solvent is produced by reducing the nickel compounds in a nickel-rich mass consisting of nickel compounds and alumina precipitated as a mixture. Instead of nickel, cobalt or iron can also be used as active metals. The only influence

mixing of higher carbohydrates with the methane has on the method is the change in the quantity of the water vapor addition. The advantage of the method lies in the fact that the addition of water vapor prevents side reactions which can lead, for example, to carbohydrate separation. Furthermore, higher carbohydrates, if they are present, react to give methane.

11668 Bigger throughputs seem unlikely before 1980. *Can. Pet.;* **19**: 23-24, 26(Apr 1975).

Canadian Petroleum's 13th annual census of gas processing indicates that there was an actual decrease in gas-plant capacity in 1974 for the first time in the history of the survey. The situation is examined with reference to market orientation and prospects for reserve tapping.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 11677, 12076, 12614, 12618

11669 Acetylene and acetylene-chemicals from natural gas. Othmer, D.F. (Polytech Inst of NY, Brooklyn). *Verfahrenstechnik (Mainz);* **11**: No. 6, 377-380(Jun 1977).

Acetylene stores in the triple bond joining its two carbon atoms a great deal of energy--so far most of this has come from the electrical energy used in the furnace which makes from lime and coke the calcium carbide which is then hydrolyzed to give acetylene. In making acetylene from hydrocarbons the large amount of energy is absorbed from a high temperature combustion, or partial combustion, or an electric arc. This reactivity resulting from the triple bond and the large amount of stored energy makes acetylene combine very readily with other materials to give, among the large number of possible derivatives, many petrochemicals. The Happel-Kramer acetylene process is described. 5 refs.

11670 Method and device for evaporating liquified natural gas. Griepentrog, H. (to Gutehoffnungshuette Sterkrade A.G., Oberhausen-Sterkrade (Germany, F.R.)). German(FRG) Patent 2,523,672/A/. 2 Dec 1976. 21p. (In German).

A process for evaporating liquefied natural gas using heat is proposed where the waste heat of thermal engines is used either alone or in addition. The waste heat is supplied by the optimisation of closed cycle thermal engines with one or several loops. The medium of the loops can be air, helium, neon, argon or nitrogen. The process, apart from the use of waste heat, permits the use of further heat from evaporators, the flue gas of heaters or boilers.

11671 Method and device for evaporating and heating liquefied natural gas. Ehlert, J.; Kraus, H.; Muenkel, J. (to Gelsenberg A.G., Essen (Germany, F.R.)). German(FRG) Patent 2,520,936/A/. 25 Nov 1976. 13p. (In German).

It is proposed to use the waste heat from thermal power stations in conjunction with sea water or brackish water desalination process according to the evaporation process for the evaporation and heating of liquefied natural gas. According to the invention thermal power stations which work with closed or open gas turbine cycles, are particularly suitable for the above mentioned process. The process is explained further by a process flow diagram and a T-S diagram.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 12617, 12618, 12625, 12626

11672 French gas industry within the worldwide framework. Blancard, J. (Gaz de Fr). *Ann. Mines;* **183**: No. 8, 15-24(Aug 1977). (In French).

Growth of the gas industry has begun with town gas but the industry gained its current international dimension thanks to natural gas. In France, the proportion of natural gas in meeting the country's needs for primary energy has enjoyed a spectacular rise over the past 15 years and, under the Plan for 1985, this contribution of natural gas to the overall energy resources is expected to increase considerably. Economic policies of the French gas industry, natural gas reserves and the future of natural gas are discussed.

11673 Gas and oil: ties and similarities. Guillaumat, P. (d'Elf-Aquitaine, Paris, Fr). *Ann. Mines;* **183**: No. 8, 25-34(Aug 1977).

The author examines the interdependence of the two industries: gas and oil, and points to their common technical aspects. A brief historical review is followed by a discussion of oil and gas reserves, world hydrocarbon production and the roie of natural gas in it, as well as the respective shares of oil and gas in energy markets. Economic comparisons between the two industries are made, and the competition for future gas resources is considered.

11674 German gas industry in the first two-year study of the Monopoly Commission. Some critical remarks. Michaelis, H. *Energiewirtsch. Tagesfragen;* **27**: No. 2, 139-146(Feb 1977). (In German).

In connection with the task to assess state and development of enterprise concentration from the point of view of economy policies and competition policies, the Monopoly Commission has made its first two-year study on the German gas industry. A substantial part of the study deals with concentration in the energy economy. The analysis at hand presents a critical view of the study and is concerned with the following three complexes: 1. The substitution competition between the various energy carriers on the heat market; 2. the 'anlegbare Preis' (the price the market is prepared to pay) which has been subjected to intensified scrutiny by the Monopoly Commission; 3. the significance of the size of the enterprise, and thus the degree of concentration for the operative possibilities in international gas business.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 12620, 13062, 13184

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

11675 (NVO/0679—1) **Rulison Field massive hydraulic fracturing experiment. Final report.** Reynolds, M. Jr. (Austral Oil Co., Inc., Houston, Tex. (USA)). Jul 1977. Contract EY-76-C-08-0679. 11p. Dep. NTIS, PC A02/MF A01.

One of the seven producing gas wells in the Rulison Field, Garfield County, Colorado, was selected for a massive hydraulic fracturing experiment. The fracture treatment (Aug. 1976) was applied in two stages treating separately the gross perforated intervals from 6198 to 6363 ft (Stage 1) and 5170 to 5630 ft (Stage 2). 485,000 gallons of gelled water, 1,070,000 pounds of sand, and 500 scf of nitrogen per barrel were used. A brief cleanup flow period was allowed between stages. The treatment was designed to extend a fracture approximately 1400 ft from the wellbore with a propped fracture width of 0.176 inches. The production increase was expected to range from 5.5 to 6.2 times the pre-treatment rate of 35,000 scf per day. Results of the massive hydraulic fracturing treatment were poor. Production of gas was enhanced by a factor of less than 2. The average flow rate during early 1977 was about 50,000 cubic feet per day. The lack of success is attributed to both low reservoir permeability and a restricted reservoir due to sand lenticularity.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 12619, 12621, 12625, 12626, 12627

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 12622, 12623, 12624

11676 Gas distribution. Andriot, J. (Gaz de Fr). *Ann. Mines;* **183**: No. 8, 53-58(Aug 1977). (In French).

Old and new gas distribution networks in France are reviewed and the tasks faced by the gas de France are outlined. The distribution techniques using both low and medium pressure are described, and special emphasis is placed on safety aspects of the French gas distribution networks. Contacts between the distributor and gas users are also considered, and the types of customer services offered by the Gaz de France are summarized.

11677 Gas and technology. Fort, R. (Gaz de Fr). *Ann. Mines;* **183**: No. 8, 59-66(Aug 1977). (In French).

This article briefly reviews the gas industry's modern techniques. In particular, great advances are noted in pipelining with respect to the pipe materials, manufacturing and joining processes, and performance. Development of compressors is outlined, and the role of underground storage reservoirs is briefly discussed. New liquefaction techniques that were developed to meet the neeeds of gas transportation and storage are also reviewed.

11678 Transport problems of liquefied natural gas. Adam, R. *Energiewirtsch. Tagesfragen;* **27**: No. 6, 424-425(Jun 1977). (In German).

11679 New TWS liquid gas filling equipment. Poll, J. (Technische Werke der Stadt Stuttgart A.G. (Germany, F.R.)). *Gas-Wasserfach, Gas-Erdgas;* **118**: No. 6, 227-229(1977). (In German).

On the 30th June 1976, one of Europe's biggest and most modern liquid gas filling installations was taken into operation at

TWS (Technische Werke der Stadt Stuttgart AG). The contribution at hand reports on the technical concept, the application to build, the construction and taking up operation.

11680 Experience in supervising the laying of submarine gas pipelines. Reuter, M.; Kniess, J. (Technischer Ueberwachungs-Verein Norddeutschland e.V., Hamburg (Germany, F.R.). Abt. Werkstofftechnik und Bauueberwachung). *Three R Int.;* **15**: No. 12, 674-686(1976). (In German).

The problem of laying submarine gas pipelines is discussed from the point of view of a technical supervisory agency which was involved in laying several of such pipelines. The problems encountered in such work and particular errors are dealt with at length in order to help facilitate operations in future projects of this kind. The pipe-laying contractor must be fully familiar with the rules and codes to be complied with and the preliminary inspection data to be submitted to the supervisory agency. This aspect is covered in detail. The authors describe the types of pipe used, the properties of the steel, the protection from corrosion and the concrete jacket provided to prevent the pipeline from lifting off the sea bed. It is shown that considerable importance has to be attached to thorough preparation and supervision of the pipe manufacturing operations and to the need for making full use of the tests and testing procedures as specific destructive and non-destructive tests cannot be carried out in the laying of submarine pipelines. The laying methods employed are described. Difficult phases of such work and the hazards involved are pointed out. In conclusion, the authors emphasize the need of preparing adequate documentation which is the prerequisite for issuing a final certificate.

11681 Process and device for the dosed feeding of additive-gas mixtures into natural-gas pipes. Buhmann, H. German(FRG) Patent 2,351,251/A/. 24 Apr 1975. 17p. (In German).

For the natural-gas supply it is necessary in case of consumption peaks or outages to partially or completely compensate the natural gas with a mixing gas. The behavior of the mixing gas used should be similar to that of the natural gas. The invention proposes to eliminate the existing difficulties in the following way: The single compounds of the mixture (like butane, propane, hydrogen and air) are brought separately to a condition which is conformable to the natural gas in the pipe. Then the components are dosed in a high-pressure mixing device. This way, the quality of the mixing gas (e.g. net calorific value, Wobbe-number) matches the natural gas. This gas mixture can be fed through a collecting vessel into the natural gas pipe. Further claims concern the design and the construction of the devices concerning dosing, conveying, regulating, and mixing.

COMBUSTION

REFER ALSO TO CITATION(S) 11579

11682 Formation of formaldehyde in the combustion of natural gas in domestic appliances. Schmidt, A.; Goetz, H. (Technische Univ., Vienna (Austria). Inst. fuer Verfahrenstechnik und Technologie der Brennstoffe). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 3, 112-115(Mar 1977). (In German).

The formation of formaldehyde in connection with the combustion of natural gas, as it occurs with burners of gas ovens used in households, is reported on. The formation mechanism, toxicity, and the analytics of formaldehyde are dealt with. The conclusion to be drawn from the emission values found is that the ventilation prescribed in guideline 2052, March 1960, of the VDI, should be installed in all kitchens as otherwise formaldehyde may present a problem.

STORAGE

REFER ALSO TO CITATION(S) 11659, 11677, 12996

11683 Storage of natural gas in salt caverns. Harms, W. *Energiewirtsch. Tagesfragen;* **27**: No. 6, 422-424(Jun 1977). (In German).

First of all, the author discusses the reasons for storing gas underground, then he discusses the possibilities of usingderground cavities for the storage of gas, and finally he deals with thoughts during the stage of planning concerning salt cavern storage types. The production and the mode of operation of natural gas caverns are also described.

11684 Method for the production of a ground storage for storing liquefied gas. Sanger, F.J. (to Conch International Methane Ltd., Nassau (Bahamas)). German(FRG) Patent 1,559,250/C/. 11 Nov 1976. 6p. (In German).

The invention refers to a method for the production of a ground storage for storing liquefied gas, esp. natural gas, under atmospheric pressure. For this reason, a ring-shaped moist region of the soil is frozen, and a store-pit is dug within this frozen region. A ring-shaped shoulder with horizontal surface is formed on the inner side of the wall, on which the ring fundament of cement is placed. A cylindric wall is constructed on this fundament. The roof is constructed on this cylindric wall. According to the invention the ring shoulder is covered with a plastic bedding consisting of low-temperature fat and a granular filling material is where the cement ring fundament consisting of prefabricated blocks is placed on and covered with a low-temperature fat before erecting the wall. The wall is made of prefabricated shells and then prestressed.

11685 Diaphragm tank for liquid gas. Kuniyasu, T.; Goto, D.; Miyanari, T. (to Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan)). German(FRG) Patent 2,347,288/B/. 21 Oct 1976. 3p. (In German).

The invention concerns a diaphragm tank for liquid gas which is installed in a supporting bowl of insulating material. The tank has flat walls, convex cylindrical edges between the adjacent walls and convex spherical corners. The diaphragm tank is prestressed at room temperature, where its free dimensions in the wall areas at room temperature are greater than those of the supporting bowl, that material stresses are reduced during filling with liquid gas at low temperatures. In order to prevent damaging peak stresses in the corners, the radius of curvature at the corners is less than that of the edges. Flat walls and corners are connected by suitably curved triangular surfaces.

OIL SHALES AND TAR SANDS

11686 (LERC/RI—77/7) Bibliography of publications dealing with oil shale and shale oil from U.S. Bureau of Mines, 1917—1974, and the ERDA Laramie Energy Research Center, 1975—1976. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). Sep 1977. 53p. Dep. NTIS, PC A04/MF A01.

BOM began investigation of shale-oil production during World War I. This research continued at a low level until the Synthetic Liquid Fuels Act in 1944 set up two major research installations at Rifle, Colorado, and at the Laramie experiment station in Wyoming. After 1956, the demonstration plant at Rifle was closed and the Laramie station (LERC) became the sole site of federal research, particularly after the Arab oil embargo. This bibliography of approximately 750 citations is arranged according to year. (DLC)

SITE GEOLOGY AND HYDROLOGY

SITE GEOLOGY

11687 Importance of reservoir description in evaluating in situ recovery methods for cold lake heavy oil--1, 2. Kendall, G.H.; Townson, D.E. (Imp Oil Ltd, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **25**: No. 2, 314-340(May 1977).

The huge reserves of heavy oil in Alberta are found in a variety of complex reserovirs. Recovery, excluding mining, will require application of some form of in situ recovery method, primarily in the better reservoirs. In Part 1 of this paper, reservoir description in the Cold Lake heavy-oil deposits is discussed under three headings: (1) Rock Properties; (2) Fluid Saturation; (3) Reservoir Geometry. On the basis of these parameters, five selected reservoir types are discussed and compared. Part 2 considers the application of the reservoir description in evaluating in situ methods. The significance of the reservoir parameters is discussed in general terms and related to the four most important in situ recovery mechanisms: steam stimulation, steam drive, combustion and solvent. 14 refs.

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 11504

OIL PRODUCTION, RECOVERY, AND REFINING

11688 Pyrolysis kinetics for oil-shale particles. Granoff, B.; Nuttall, H.E. Jr. (Sandia Lab, Albuquerque, NM). *Fuel;* **56**: No. 3, 234-240(Jul 1977).

A study was made to gain better understanding of the mechanism of thermal decomposition of oil shale. A series of experiments were conducted on particles of oil shales. Machined samples of uniform geometry were suspended in a nitrogen stream and pyrolysed over a range of temperatures (384-520°C), while weight losses

were continuously measured. Other samples were partially pyrolysed, quenched, cross-sectioned and visually examined to aid in the understanding of the pyrolysis mechanism. Photographs of partially pyrolysed samples are included and discussed. Two mathematical models were developed in order to represent the pyrolysis process. 13 refs.

11689 Mao-ming: an oil-producing city in South China. *Ti-li Chih-shih;* No. 7, 17(Jul 1976). (In Chinese).

Mao-ming is in the southwestern Kwangtung. Nearby there are abundant reserves of oil shale in a Tertiary shallow-water gulf deposit. Average oil content is 9 to 11 percent. Large-scale exploitation was begun in 1958. Since the Cultural Revolution, the Maoming Petroleum Industrial Corporation has produced gasoline, diesel oil, kerosene, gear oil, aqua ammonia, and asphalt. Petrochemicals, such as Ch'ing-lun (2532/4858) [acrylic], plastics, chemical fertilizers and pesticides, are also made in large amounts. The product line numbers more than 70.

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 11443, 11687, 12542

11690 Field test of reverse-combustion oil recovery from a Utah tar sand. Land, C.S.; Cupps, C.O.; Marchant, L.C.; Carlson, F.M. (US ERDA, Laramie, Wyo). *J. Can. Pet. Technol.;* **16**: No. 2, 34-38(Apr-Jun 1977).

A field experiment to recover oil from tar sand by reverse combustion was conducted at Northwest Asphalt Ridge, near Vernal, Utah. This test was in a 10-foot interval of the Rim Rock sandstone member of the Mesa Verde Formation at a depth of approximately 300 feet. Ignition was accomplished on November 25, 1975, and the reverse combustion front was propagated successfully through the formation. Although the formation of the cracked products of reverse combustion was less than expected, this recovery process may be used successfully to heat the tar sand reservoir to a temperature high enough that the bitumen becomes mobile enough to be produced. 5 refs.

11691 Bitumen upgrading--its importance to the in-situ producer. Simmer, M.; Thompson, D.C. (In-Situ Res and Eng Ltd, Edmonton, Alberta). *J. Can. Pet. Technol.;* **16**: No. 2, 49-53(Apr-Jun 1977).

This paper explores the substantial effect on the producing operation of the selection and design of upgrading and utilities plants in an in-situ oil sands scheme. Oil sands bitumen contains large amounts of impurities which have to be removed in converting (upgrading) to synthetic crude. This upgrading increases the hydrogen-carbon ratio and removes the sulfur and nitrogen present in the crude bitumen. There are a number of processes which are suitable for bitumen upgrading. Two of the most promising processes are described, including schematic process flow diagrams and yield slates. 3 refs.

11692 Propagation of the burning front of oil in a porous medium. Bogopol'skii, A.O.; Sharifov, Ya.A. *Combust., Explos. Shock Waves (USSR) (Engl. Transl.);* **12**: No. 1, 6-12(1976).

The burning of oil in a porous medium has been examined in the context of the problem of intensifying the development of oil deposits. The results of an experimental study of the rate of propagation of a plane burning front of oil, depending on the filtration rate of the oxidizer, pressure, oil density, and degree of water saturation of the porous space are given. 12 refs.

REFINING

REFER ALSO TO CITATION(S) 11691, 11809

11693 (FE—2315-12) **Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Quarterly report, January—March 1977.** Sullivan, R.F. (Chevron Research Co., Richmond, Calif. (USA)). Oct 1977. Contract EX-76-C-01-2315. 32p. Dep. NTIS, PC A03/MF A01.

The objective of this program is to determine the feasibility and estimate the economics of hydroprocessing four synthetic fuels to distillate fuels, including high octane gasoline, using presently available technology. The feedstocks include three coal-derived synthetic crudes and shale oil. The first feedstock is Paraho crude shale oil, produced in the indirectly heated mode. Whole shale oil was hydrofined in a 2000-hour pilot plant test using ICR 106 catalyst. The results show that shale oil containing 2.2 percent nitrogen can be hydrofined to residuum-free product containing 1 to 2 ppM nitrogen in a single stage. Process design studies indicate that it is preferable to hydrofine the whole shale oil to about 500 ppM nitrogen and then to fractionate the product before conventional downstream processing to produce transportation fuels. The product resembles the fraction of a waxy petroleum crude boiling below 1000°F. This report includes yields and product properties determined from the small-scale pilot plant test. A larger-scale pilot plant demonstration run is now in progress.

PURIFICATION

REFER ALSO TO CITATION(S) 11691, 11693

11694 (CONF-770814—9) **Catalytic hydroprocessing of shale oil to produce distillate fuels.** Sullivan, R.F.; Stangeland, B.E. (Chevron Research Co., Richmond, Calif. (USA)). 1977. Contract EX-76-C-01-2315. 42p. Dep. NTIS, PC A03/MF A01.

From American Chemical Society meeting; Chicago, IL, USA (29 Aug 1977).

Results are presented of a Chevron Research Company study sponsored by the Energy Research and Development Administration (ERDA) to demonstrate the feasibility of converting whole shale oil to a synthetic crude resembling a typical petroleum distillate. The synthetic crude thus produced can then be processed, in conventional petroleum-refining facilities, to transportation fuels such as high octane gasoline, diesel, and jet fuel. The raw shale oil feed used is a typical Colorado shale oil produced in a surface retort in the so-called indirectly heated mode. It is shown that whole shale oil can be catalytically hydrodenitrified to reduce the nitrogen to levels as low as one part per million in a single catalytic stage. However, for economic reasons, it appears preferable to denitrify to about 0.05 wt % nitrogen. The resulting synthetic crude resembles a petroleum distillate that can be fractionated and further processed as necessary in conventional petroleum refining facilities. Shale oil contains about 0.6% sulfur. Sulfur is more easily removed by hydrofining than is nitrogen; therefore, only a few parts per million of sulfur remain at a product nitrogen of 0.05 wt %. Oxygen contained in the shale oil is also reduced to low levels during hydrodenitrification. The shale oil contains appreciable quantities of iron and arsenic which are also potential catalyst poisons. These metals are removed by a guard bed placed upstream from the hydrofining catalyst. Based on correlations, the naphthas from the shale oil hydrofiner can readily be upgraded to high octane gasolines by catalytic reforming. The middle distillate fractions may require some additional hydrofining to produce salable diesel or jet fuel. The technology is available, and pilot plant studies are scheduled to verify diesel hydrofiner performance.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 11579, 11662, 11663, 11691

11695 (UCID—17616) **Determination of carbonate minerals in oil shales.** Lim, R.; Gregory, L.J.; Leach, K.L.; Deutscher, S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1977. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

The quantification of carbonate minerals in oil shales is necessary for computer modeling and for interpretation of oil shale block experiments in the LLL Oil Shale Program. A method of analysis similar to one proposed by the Laramie Energy Research Center was investigated. Their method is based on successively leaching the sample with water and acid. The water extracts nahcolite. The acid treatment extracts dawsonite, dolomite, calcite, and ferroan. The cations are determined individually by atomic absorption and flame emission spectrophotometry, and from this information the respective carbonate minerals are calculated by assignment of the cations. We found good agreement with LERC for magnesium results, but our calcium results were generally higher compared to LERC calcium results. We have found that small amounts of noncarbonate minerals yielding acid extractable calcium are present in oil shales. The result obtained by this method is a semiquantitative analysis of the carbonate minerals.

11696 Electron spin resonance study of free radicals in athabasca asphaltene. Niizuma, S.; Steele, C.T.; Gunning, H.E.; Strausz, O.P. (Univ of Alberta, Edmonton). *Fuel;* **56**: No. 3, 249-256(Jul 1977).

Asphaltene is a ubiquitous constituent of crude petroleum and bitumen. Its concentration may vary from a few tenths of one percent in very light crudes to 25% in heavy bitumens. A quantitative treatment of the enhancing effect based on the Langmuir adsorption isotherm made it possible to derive an activation energy of approximately 17 kJ/mol for the dissociation of the oxygen-asphaltene complex and to evaluate the temperature variation of the number of radical pairs which contribute to the intensity variation. The kinetics of the spontaneous relaxation of the O_2-asphaltene system were also investigated. 17 refs.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 11689

WASTE RESEARCH AND MANAGEMENT

11697 Effect of chemical agents on settling rates of sludges from effluent of hot-water extraction of athabasca oil sands. Hocking, M.B.; Lee, G.W. (Univ of Victoria, BC). *Fuel;* **56**: No. 3, 325-333(Jul 1977).

Tailings pond sludges comprising water, clay, and bitumen mixtures have been treated thermally and with varying levels of electrolytes, acids, oxidizing and reducing agents, and organic flocculating agents to determine optimum conditions for both settling rate and ultimate cake percent solids. Hydrochloric acid and sulfur dioxide were among the most efficient agents and their action could be further enhanced by combining with one of the other methods. 35 refs.

11698 Physical characterization and microbiological settling-rate modification of aqueous suspensions from hot-water-process oil-sands extraction. Hocking, M.B. (Univ of Victoria, BC). *Fuel;* **56**: No. 3, 334-339(Jul 1977).

Sealed samples of specific aqueous hot-water-process-tar-sands-extraction streams and tailings pond sludges have been examined microbiologically and shown to contain compatible microorganisms. Portions of these have been treated aerobically and anaerobically, with and without added nutrient, to encourage hydrocarbon utilziation. While both aerobes and anaerobes appear to be indigenous in the matrices examined, aerobic treatment with nutrient present was found to give optimum solids-settling performance. 13 refs.

NUCLEAR FUELS

11699 Review of the uranium industry in the U.S.A. Davis, J.R. (Rocky Mountain Energy Co., Denver, Colorado (USA)). pp 109-112 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The 145 000 MWe of nuclear capacity that will be operational in the U.S.A. by 1985 will demand an annual production of U_3O_8 of 39 000 tons (the 1976 figure is 17 000 tons). The short term pressures on the uranium industry to expand mining and milling capacity and the long-term pressures to discover more uranium and to increase basic reserves are therefore readily apparent. Milling capacity, for example, must grow from 28 000 tons of ore per day at present to 145 000 ton/day by 1985. In the face of these estimated requirements it is clear that changes in traditional exploration, mining and milling methods must take place. Current and possible future developments in exploration, mining and processing in the U.S.A. are outlined, as are the effects of increasingly important political and environmental considerations. Finally, mention is made of the governmental programme which is designed to provide industry with the data and technology needed for exploration and mining and to assess American uranium resources.

RESERVES

11700 (TM—198) **Uranium in the San Juan Basin: an overview.** Chenoweth, W.L. (Energy Research and Development Administration, Grand Junction, Colo. (USA). Grand Junction Office). May 1977. 6p. Dep. NTIS, PC A02/MF A01.

Uranium deposits in the San Juan Basin occur principally in continental, fluvial sandstones of the Morrison Formation of Jurassic age. A cluster of large deposits in McKinley, Sandoval, and Valencia Counties, New Mexico, comprises the Grants Mineral Belt, the largest uranium area in the United States. During 1948 through 1976, underground and open-pit mines in the San Juan Basin have produced 119, 163 tons of uranium oxide (U_3O_8). This amounts to 40% of the total United States' uranium ore production. The discovered ore reserves and the favorable geology for undiscovered potential resources of the basin are expected to maintain New Mexico's position as the nation's principal source of uranium for years to come.

11701 Gulf digs in to tap a major uranium orebody. Jackson, D. *Eng. Min. J.;* **178**: No. 8, 73-79(Aug 1977).

The progress and future plans of Gulf Mineral Resources Co. for tapping and developing a major uranium orebody via two concrete-lined shafts in the Grants uranium mineral belt in New Mexico are discussed. The mineralogy of the Grants belt is discussed as it relates to the Gulf development project. Numerous pictures of the operation are included. (BLM)

11702 US uranium industry continues active development despite nuclear uncertainties. Davis, J.F. *Eng. Min. J.;* **178**: No. 8, 91-94(Aug 1977).

Current moderate, though significant, expansion of nuclear power now expected in the face of apparent opposition will necessitate changes in the traditional methods of exploration, mining, and milling if the uranium-supplying industry is to respond in sufficient time. Exploration efforts in known districts are discussed. Both the sandstone type deposits and some of the recent "hardrock" discoveries are surveyed. Trends in mining and processing both types of ores and discussion of how the trends can help meet the increased demand for yellow cake are presented. A very brief discussion of ERDA's NURE program designed to provide industry with exploration data and technology to assess US uranium resources is included. (BLM)

11703 World uranium resources. Cameron, J. (Int At Energy Agency, Vienna, Aust). *Berg- Huettenmaenn. Monatsh.;* **122**: No. 6, 219-232(Jun 1977).

The most authoritative studies of world supply and demand of uranium are produced in reports of an international working group jointly sponsored by the Nuclear Energy Agency of OECD and the International Atomic Energy Agency. The most recently published study (December 1975) indicates that the nuclear power capacity existing at the end of 1976 was about 80,000 electrical megawatts (MWe) and the study went on to predict that this would grow to 500,000 MWe by the year 1990. Translated into annual requirements for uranium this means that from the present consumption of about 24,000 metric tons uranium the growth will be to between 165,000 and 350,000 metric tons uranium in the years 2000-2010. The total cumulative requirement will be about three million tonnes uranium. To offset this requirement, the NEA/IAEA estimate of December 1975 of low cost reserves was 1,080,000 tonnes U. Estimated additional resources amounted to another one million tonnes. Some additional reserves have been proven since the end of 1975. 8 refs.

EXPLORATION

REFER ALSO TO CITATION(S) 11702, 13564

11704 (DPST—77-146-1) **Savannah River Laboratory hydrogeochemical and stream sediment reconnaissance. Preliminary raw data release Winston-Salem 1^0 x 2^0 NTMS area, North Carolina, Virginia, Tennessee. National Uranium Resource Evaluation Program.** Baucom, E.I.; Price, V.; Ferguson, R.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1977. Contract EY-76-C-09-0001. 188p. (GJBX—66-77). Dep. NTIS, PC A05/MF A01.

This report presents preliminary results of stream sediment reconnaissance in the Winston-Salem National Topographic Map Series (NTMS) 1^0 x 2^0 quadrangle. Stream sediment samples were collected from small streams at 1399 sites for a nominal density of one site per 13 square kilometers (five sq mi) over this area. Neutron activation analysis (NAA) results are given for uranium and 15 other elements. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tabular and map format. Statistical summaries of all data and a brief description of results are given. The geology of the report area is summarized, and a generalized geologic map is provided. Key data are presented in page-sized hard copy, and supplementary data are on microfiche. Key data include (1) water quality measurements (pH, conductivity, and alkalinity), (2) elements related directly to potential uranium and thorium mineralization in crystalline rock (U, Th, Hf, Cc, and Dy), and (3) elements useful for geologic classification of the sample area (Ti, V, Fe, Mn, Al, and Sc). Supplementary data include sample site descriptors (stream characteristics, vegetation, etc.) and supplementary elements that may be useful (Eu, Tb, Ta, Cs, and F).

11705 (UCRL—52000-77-5, pp 23-28) **Western states uranium resource survey.** Tinney, J.F. May 1977.

In Energy and technology review.

ERDA's National Uranium Resource Evaluation (NURE) program was established to provide a comprehensive description of uranium resources in the United States. To carry out this task, ERDA has contracted with various facilities, including universities, private companies, and state agencies, to undertake projects such as airborne radiometric surveys, geological and geochemical studies, and the development of advanced geophysical technology. LLL is one of four ERDA laboratories systematically studying uranium

distribution in surface water, groundwater, and lake and stream sediments. We are specifically responsible for surveying seven western states. This past year we have designed and installed facilities for delayed-neutron counting and neutron-activation analysis, completed seven orientation surveys, and analyzed several thousand field samples. Full-scale reconnaissance surveys began last fall.

11706 Recent advances in uranium exploration with electronic alpha cups. Warren, R.K. (Esso East Inc, Houston, Tex). *Geophysics;* **42**: No. 5, 982-989(Aug 1977).

Data from a new radon measuring device, based on electronic alpha cups are compared with data from the nonelectronic, plastic alpha cups commonly used in exploring for uranium. A burial time of three days appears to be adequate for the electronic alpha cups to collect exploration data equivalent to those from plastic sensing devices. The advantages of the electronic cups are short time of burial and instant readout in the field; the major disadvantages is the capital expenditure required for the instruments. It is possible the cups may be useful for copper exploration too. 5 refs.

MINING

REFER ALSO TO CITATION(S) 11702, 11749, 12565

11707 (DOCKET-408452—1) **Bear Creek Project. Final environmental statement.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Jun 1977. vp. NTIS $11.00.

The Bear Creek Project consists of certain mining and milling operations involving uranium ore deposits located in Converse County, Wyoming. Mining of uranium from nine known ore bodies will take place over a period of ten years (estimated); a mill with a nominal capacity of 1000 tons per day of ore will be constructed and operated as long as ore is available. The waste material (tailings) from the mill, also produced at a rate of about 1000 tons per day, will be stored onsite in an impoundment. Environmental impacts and adverse effects are summarized. (LK)

11708 Uranium mining at Lisbon, Utah. *Min. Mag.;* **137**: No. 2, 106-107, 109, 111-112(Aug 1977).

Underground development, mining methods and ore processing by Rio Algom Corp. at Lisbon, Utah, are featured here. The company must contend with the depth and irregularity of the mineralized beds, major and minor faulting, and the hazard of water bearing beds and pockets. Moreover, ore processing plants must adhere to strict pollution and environmental control regulations.

11709 Economic development in uranium mining in witwatersrand. Hentrich, W. *Glueckauf;* **113**: No. 10, 510-512(19 May 1977). (In German).

History of U_3O_8 production since 1952 is reviewed, and causes of production increases and setbacks are analyzed. Utilization of new ore treatment equipment is reported. 2 refs.

FEED PROCESSING

REFER ALSO TO CITATION(S) 11707, 11708, 11709, 11722, 11723

11710 Uranium recovery from copper leaching operations. Brooke, J.N. (Wyo Miner Corp). *Min. Congr. J.;* **63**: No. 8, 38-41(Aug 1977).

Extensive evaluation of alternatives confirmed that the Eluex process, which had been used by the USBM and Kennecott, was the most suitable. Resin ion-exchange is the primary uranium recovery process. Since the copper leach solution is a weak sulfuric acid solution, it is natural to use a strong sulfuric acid solution for stripping uranium from the resin. By maintaining a common anion system, no long-term changes are caused to the leaching or recovery systems. Using solvent extraction has three benefits: it permits recycling of the strip solution, yielding major savings in sulfuric acid; it permits a further concentration of the uranium, yielding improved operation of the yellowcake precipitation and dewatering sections of the plant; and it further purifies the uranium by rejecting contaminating ions. 2 refs.

11711 Bacterial oxidation to raise uranium extraction rate. *S. Afr. Min. Eng. J.;* No. 4127, 61-63(Apr 1977).

General Mining and Finance Corporation is using bacteria for the oxidation of ferrous iron in its uranium extraction process. The process is expected to raise the uranium extraction rate by 4% while cutting operation costs by 8% through reduction of the use of manganese dioxide and sulfuric acid.

ENRICHMENT

REFER ALSO TO CITATION(S) 11746, 12566

11712 (PER—10) **Basic information relating to uranium-enrichment calculations and fuel requirements for nuclear power reactors.** Brown, K.T. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Feb 1977. 28p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Quantitative information is provided to enable non-specialists in the nuclear field to calculate feed and separative-work requirements involved in the enrichment of uranium. Representative uranium and separative-work consumption rates for various common nuclear power reactors are also presented.

11713 Chemical and ion exchange in isotope separation with special reference to heavy elements. II. Computer calculations for multiplication of isotope effect corresponding to isotopic exchange processes. Gard, E.; Calusaru, A. (Institutul de Fizica Atomica, Bucharest (Romania)). *Isotopenpraxis;* **13**: No. 5, 174-178(May 1977).

By computer calculation three cases of multiplication of isotope effect, corresponding to peculiar parameters of isotopic exchange reactions between U(IV)sub(resin) and U(VI)sub(solution) were considered: (1) inverse breakthrough; (2) direct break-through and 3) band displacement processes. In the first case the interesting part is located at the end of the elution curve, where a sharp decrease of ^{235}U content occurs. In the second case the frontal part is enriched in ^{235}U. Although the band displacement is a combination of both direct and inverse break-through processes, only in this case it is possible to obtain an equilibrium isotopic composition of the band, corresponding to the maximal isotopic modification of the whole uranium adsorbed in the band. The stationary equilibrium isotopic composition depends on the displacement length of the band, which is increased when the band is longer; it depends also on the physicochemical factors and especially on the equilibrium constant (separation factor) of the isotopic exchange reaction.

11714 New method of separating isotopes by using plasma. Takayama, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Proc. Jpn. Conf. Radioisot.;* No. 12, 336-337(Jun 1976). (In Japanese).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

The formation of the plasma of uranium and the treating quantity of uranium by the method of sheet plasma resonance is studied. The disadvantages of the conventional uranium enrichment process are that it requires too much electric power to produce plasma, and that the treating quantity of uranium is very small. The new apparatus for producing sheet plasma has twenty four coils radially arranged on a circular periphery, 50 cm apart from the center. These coils make uniform parallel magnetic field. Two parallel electrodes for applying high frequency, and at the same time, for collecting uranium are placed within this magnetic field. In a perpendicular section to the center axis, the arrangement of magnetic field makes a picket fence, so that there is no magnetic field in the inside. Plasma is formed by the surface ionization of two white-heated disks (10 to 15 square centimeter) disposed at the opposite ends on the center line of a cylindrical space surrounded by the picket fence. The plasma formed in the part without magnetic field diffuses along the parallel magnetic field to circumference. The Larmer radius of uranium-235(+) is continuously increased by applying the high frequency that resonates to U-235(+) to the sheet plasma to let it adhere to the electrodes. The maximum treating quantity is 2,800 kg at the plasma density of 3.6×10^{12}/cc.

11715 Development separation method of isotopes. Miyake, T.; Takeda, K.; Ikeda, A.; Imamura, K.; Seko, M. (to Asahi Chemical Industry Co. Ltd., Osaka (Japan)). Japanese Patent 1976-143,200/A/. 5 Jun 1975. 6p. (In Japanese).

A process using anion exchange resin to separate isotopes is claimed, wherein grains of anion exchange resin having a specific grain size are used to thereby efficiently separate the isotopes. A method of separating uranium isotopes, separates isotopes while effecting oxidation and reduction in (A), an interface between zone of uranium adsorption and zone of reducing agent adjacent thereto; or (B), an interface between zone of uranium adsorption and zone of oxidizing agent; or both interfaces (A) and (B), in a system where anion exchange is present, wherein grains of granular anion exchange resin, which average grain size of all grains is in the range from 160 microns to 15 microns, are used.

CENTRIFUGATION

11716 New proposal for a gas centrifuge rotating differentially. Matsuda, T. (Univ Coll, Cardiff, Wales). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 756-757(Dec 1976).

Usually the main body of gas centrifuges is a cylinder rotating rigidly, i.e. with the angular speeds of the top and the bottom plates and that of the side wall the same. The author proposes an alterna-

tive device in which the top and the bottom plates rotate much faster than the outer side wall, leading to a faster rotational speed for the gas. 12 refs.

LASER EXCITATION

11717 Present status of 16-μm lasers for laser isotope separation of UF_6. Yamanaka, M. (Osaka Univ., Suita (Japan). Faculty of Engineering). *Rikagaku Kenkyusho Hokoku;* **4**: No. 1, 3-18(Jun 1976).

Laser isotope separation (LIS) techniques are reviewed. In 1972, the Q-slope method was applied for LIS with 10.6 micrometer carbon dioxide laser, the output of which was large. The separation factor of 1.1 was realized. At present, it is considered that 16 micrometer laser will be a powerful tool for LIS. Various types of laser systems are under development. The 16.58 micrometer carbon dioxide laser will have the output power of about 100 W by CW oscillation. The improvement of neon laser has not been in progress. More than 1100 oscillation lines have been observed in the photo-excitation gas laser. The 16.18 micrometer four wave parametric generation, optically pumped sulfur hexafluoride and optically pumped carbon dioxide lasers are investigated. The development of wave lenght-tunable lasers are remarkable. Semiconductor laser, different frequency light mixing, optical parametric oscillator, four wave parametric mixing, spin-flip Raman laser, dye laser-excited Raman laser, Polariton Raman laser, and free-electron laser are studied.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 12200

11718 (ANL—76-126) **Cs—U—O phase diagram and its application to uranium—plutonium oxide fast reactor fuel pins.** Fee, D.C.; Johnson, I.; Davis, S.A.; Shinn, W.A.; Staahl, G.E.; Johnson, C.E. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A04/MF A01.

Portions of the cesium-uranium-oxygen system have been investigated between 873 and 1273°K and a phase diagram has been constructed using our data and the data of other workers in the field. Thermodynamic and kinetic data have been used to examine the reactions that occur in fast-reactor fuel pins between fission-product cesium and the uranium oxide blanket. It was concluded that at the low oxygen potentials existing at the interface between the uranium-plutonium mixed-oxide and the uranium oxide blanket, Cs_2UO_4 is the only Cs-U-O compound expected to be formed in the uranium oxide blanket.

11719 Process of making oxygen enriched plutonium dioxide (PuO_2). Kruger, O.L. (to Nuclear Battery Corp.). US Patent 4,042,670. 16 Aug 1977. Filed date 1 Oct 1974. 6p.

A process for enriching $^{238}PuO_2$ with ^{16}O and forming sintered fuel pellets therefrom is described comprising the steps of compressing a mass of $^{238}PuO_2$ containing ^{16}O, ^{17}O and ^{18}O into a pellet; exposing the pellet to an atmosphere of ^{16}O and an inert carrier gas at an increasing temperature up to about 1400°C with varied gas flow to obtain an exchange of ^{17}O and ^{18}O and the simultaneous sintering of the pellet; and cooling the sintered and exchanged pellet.

11720 In-line monitoring of effluents from high-temperature gas-cooled reactor fuel particle preparation processes by mass spectrometry. Lee, D.A.; Constanzo, D.A.; Stinton, D.P.; Carpenter, J.A. Jr.; Rainey, W.T. Jr.; Carter, J.A.; Canada, D.C. (Oak Ridge Natl Lab, Tenn). *Nucl. Technol.;* **34**: No. 1, 89-97(Jun 1977).

The carbonization, conversion, and coating processes in the manufacture of high-temperature gas-cooled reactor fuel particles have been studied with the use of a time-of-flight mass spectrometer. Noncondensable effluents from these fluidized-bed processes have been monitored continuously from the beginning to the end of the process. The processes monitored are these: uranium-loaded ion exchange resin carbonization, the carbothermic reduction of UO_2 to UC_2, buffer and low-temperature isotropic pyrocarbon coatings of fuel kernels, SiC coating of the kernels, and high-temperature particle annealing. Changes in concentrations of significant molecules with time and temperature have been useful in the interpretation of reaction mechanisms and optimization of process procedures.

11721 Determination of the fission-product distribution in SiC coating layer of fuel particles. Fukunda, K.; Iwamoto, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Mikrochim. Acta;* **1976**: No. 1, . 99-110(Aug 1976).

The stepwise removal of SiC coating layer of the coated fuel particles has been studied with several fused alkalis. Treatment by a mixture of KOH and Na_2CO_3 in the ratio 4 : 1 at 800° is most suitable for the removal to determine the distribution of fission products. The distribution of fission products, including gases, can be determined by this method.

11722 Pyrolitic carbon coatings for nuclear fuels from commercial butane. II. Mechanism of pyrolytic carbon deposition in spouted beds. Abdel Razek, I.D.; Abdel Halim, A.S. (Atomic Energy Establishment, Inshas (Egypt)). *Arab J. Nucl. Sci. Appl.;* **9**: No. 2, 95-103(Feb 1976).

The process of pyrolytic carbon deposition on UO_2 semi-spherical particles (310 μm diameter) in a spouted bed is analyzed and an approximate model is introduced. Data on coating efficiency and density was used to calculate a process rate constant assuming a first order kinetics. Coatings deposited at relatively low temperatures are associated with high activation energies and laminar microstructures. High temperature deposited coatings are associated with low activation energies and isotropic microstructures. Deposition from methane and from commercial butane with the activation energies of the pyrolysis reactions of the two hydrocarbons indicated that mass transfer controls the deposition process at relatively high temperatures whereas kinetics controls the process at low temperature. Variation of the activation energies with temperatures are associated with changes in the microstructures.

11723 Pyrolytic carbon coatings for nuclear fuels from commercial butane. 1. Coating parameters. Abdelrazek, I.D.; Abdelhalim, A.S. (Atomic Energy Establishment, Inshas (Egypt)). *Arab J. Nucl. Sci. Appl.;* **9**: No. 1, 63-72(Jan 1976).

Uranium dioxide and graphite semi-spherical particles (average diameter = 300 um) were coated with pyrolytic carbon at relatively low temperatures (800 to 1200°C). The spouting gas was a mixture of commercial butane and nitrogen. The hydrocarbon served as a source for carbon whereas nitrogenated as a diluent and a support for the bed. The total gas flow rate was 3.5 liters/min and the hydrocarbon content varied from 3 to 10%. Coating efficiencies ranging from 4 to 25 percent were obtained. The densities of the coatings varied from 1.25 g/cm^3 (which corresponds to coatings of laminar microstructures) and 1.82 g/cm^3 (which suggests the formation of isotropic coatings. Metallographic examination (using polarized light) of the pyrolytic carbon formed at the experimental conditions indicated the possibility of using the coatings for nuclear fuel applications.

11724 Changes of microstructures in uranium oxides during the sintering process. Breschi, R.; Olivi, A. (Centro Applicazioni Militari Energia Nucleare, S. Piero a Grado (Italy)); Camanzi, A. (AGIP Nucleare, Milan (Italy)). *Energ. Nucl. (Milan);* **23**: No. 6, 317-322(1976).

In this work the effects are considered of different presintering thermal treatments on sintered microstructures of uranium oxide microspheres. In particular, a strict analogy is observed between structures of ammonium polyuranate microspheres at the end of decomposition and in the very first growth stage of crystallites, and structures of presintered UO_2, unpressed powders.

11725 Method of preventing contamination by grain molder. Matsumoto, K.; Awada, Y.; Kamiyama, H. (to Nippon Atomic Industry Group Co. Ltd., Tokyo). Japanese Patent 1976-123,500/A/. 19 Apr 1975. 3p. (In Japanese).

A simple means is provided to prevent contamination by scattering of radioactive substance from a uranium dioxide grain molder used within a hot cell. Sattering of grain from a grain molder for press molding grain having intense radioactivity and comprising a hammer, mortar, hammer plunger, agitating motor and feeder is prevented by a cover. Also, grain within the cover and grain within the feeder are removed by tetting air from nozzle pipes provided on the top and sides of the molder. After removal, air is switched over to rinsing liquid issued to wash off grain having been attached to the molder, followed by jetting of hot air for drying.

SPENT FUELS REPROCESSING

11726 (DPST-AFCT—77-1-2) **Alternate fuel cycle technologies. Quarterly report, April—June 1977.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1977. Contract EY-76-C-09-0001. 154p. Dep. NTIS, PC A08/MF A01.

This quarterly report describes studies to provide information needed to close the back end of the commercial light-water reactor (LWR) fuel cycle. These efforts are directed primarily at reprocessing and recycle of uranium and plutonium from spent LWR fuel. Research is reported in the following categories: environmental studies, fuel receipt, head-end processes, purex process, waste management, safeguards (dose rate for extraction streams), and general support.

11727 (IRS—290) **Studies for a comparison of the maximum possible consequences of accidents in a reprocessing plant and a nuclear power station.** Bachner, D.; Holm, D.; Meltzer, A.; Morlock, G.; Neusser, P.; Urbahn, H. (SEE ALSO- 2795680 Institut fuer Reaktorsicherheit der Technischen Ueberwachungs-Vereine e.V.,

Koeln (Germany, F.R.)). Aug 1976. 42p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The article aims at comparing the danger potential of a commercial reprocessing plant with that of a large NPP. For doing this, the radiological effects of a so-called 'Super-MCA' were tested with no safety measures: melting of the fuel element receiving area and of the concentrate containers of a reprocessing plant and core meltdown. The tables contain the doses calculated for the critical organs for the distances 1, 10 and 100 km. The investigations demonstrate that there are no principal differences in the safety of a reprocessing plant and a NPP under those hypothetical pessimistic assumptions.

11728 (KFK-tr—517) **Developing an apparatus to clear the solutions before extractive reprocessing of LWR fuel elements.** Rozen, A.M.; Dolgova, K.A.; Nudel, A.M.; Balakin, I.M.; Mal'tsev, I.M.; Koblov, V.I.; Levishchev, A.N.; Borisov, B.R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Internationales Buero/Uebersetzergruppe). Mar 1977. 14p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The article deals with the development of an industrial clarification apparatus for the clearing of solutions produced before the extractive reprocessing of fuel elements. The filtering processes with the aid of cartridge-type filters is studied using simulation solutions. Tests of the trial filter and problems in centrifuging the suspensions of LWR fuel pins are described. The novel apparatus, which consists of a cartridge-type filter and a centrifuge with an output of approximately 1 m^3/h, guarantees a high degree of purity of the solutions treated.

11729 (KFK-tr—518) **Determination of the T and Kr content of LWR fuel elements and investigation of their distribution in the course of the preparations for fuel element reprocessing.** Ageenkov, A.T.; Buravtsov, A.A.; Valuev, E.M.; Golubev, L.I.; Ershova, Z.V.; Kravtsev, V.V.; Shvoev, A.F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Internationales Buero/Uebersetzergruppe; Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Heisse Chemie). 1976. 7p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The total content of T and ^{85}Kr in fuel elements (including gas phase, fuel and can) is determined, and the T and ^{85}Kr distribution during mechanical chopping of the fuel rods in the temperature range from 50° to 700°C and while dissolving the fuel elements in HNO_3 is studied. Tritium release from chopped fuel rods is low at temperatures below 200°C, while for 200° to 700°C there is logarithmic temperature dependence. For ^{85}Kr, on the other hand, there is a logarithmic temperature dependence for the whole temperature range from 50° to 700°C. The tritium content while dissolving the fuel rod in HNO_3 was determined in solution and in the gas phase, while the ^{85}Kr content was determined in the total gas pahse. The absorption of Tr in the gas phase by the cladding material was studied experimentally. The total T and ^{85}Kr content in the LWR fuel elements could be determined from the experimental results.

11730 Nuclear power and proliferation. Barnaby, F. (Stockholm International Peace Research Inst. (Sweden)). *New Sci.;* **75**: No. 1061, 168-170(21 Jul 1977).

A case for making the drift by many countries into the acquisition of nuclear weapons more difficult by limiting nuclear fuel reprocessing capabilities is argued. It is felt that only now the ominous military significance of a whole-hearted advanced nuclear power programme is coming to the public attention and that political safeguards should be assured before an energy policy based on nuclear reprocessing and fast breeder reactors is entered into. The fact has to be faced that a way to establish a viable non-proliferation regime has yet to be found. Until a way has been found, activities involving the most sensitive elements of the nuclear fuel cycle that can be delayed should be delayed. To extend reprocessing facilities at this time is simply asking for trouble.

11731 Importance of nuclear fuel reprocessing. Allday, C. (British Nuclear Fuels Ltd., Risley). *Atom (London);* No. 249, 136-139(Jul 1977).

From Atomic Industrial Forum conference on international commerce and safeguards for civil nuclear power; New York, USA (14 Mar 1977).

The subject is discussed under the following main headings: introduction; world energy requirement; energy conservation and the economics of recycle; environmental considerations and the timescale of reprocessing; and problems associated with reprocessing. It is concluded that reprocessing is essential to the conservation of the world's energy resources and is an environmentally and probably an economically more acceptable option to the 'throw away' alternative. The associated problems of proliferation and terrorism, although of the utmost importance, can and will be solved.

11732 Reprocessing the truth. Bunyard, P. *Econ. Stat. Ber.;* **7**: No. 5, 196-197(Jun 1977).

The proposals by British Nuclear Fuels Limited, to refurbish its Magnox reprocessing plant, to develop the vitrification process for radioactive waste, and to build a commercial thermal oxide fuel reprocessing plant, are discussed, with particular reference to radiation hazards.

11733 Current problems in recycling on nuclear fuels. Scheuten, G.H. *Energie;* **29**: No. 6, 173-175(Jun 1977). (In German).

Factors affecting the economical reprocessing of spent nuclear fuels are cited. The reasons for storage of spent fuel to be processed in the future are given. It was concluded that it does not pay to reprocess spent fuel under present circumstances.

11734 Facility for the separation of krypton and recuperation of xenon. Boell-Djoa, S.H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Allgemeine Technologie). *Kerntechnik;* **19**: No. 4, 165-170(Apr 1977). (In German, English).

A facility is described by means of which the fission inert gases ^{85}Kr and xenon from spent fuel particles can be separated by fractionated freezing-out and subsequent distillation to such an extent that the xenon contains less than 1 ppb ^{85}Kr. Then, in accordance with the stringent regulations, the krypton can be conveyed to definitive storage in special bottles, whereas the xenon can be released for industrial uses.

11735 Investigation into gas-thermal treatment of APS fuel elements for core decladding. Martynovskikh, G.P.; Ageenkov, A.T.; Arduanov, M.M. (and others). *At. Energ. (USSR);* **42**: No. 2, 91-93(Feb 1977). (In Russian).

Hydrogen treatment of APS non-irradiated unprocessed fuel elements has been investigated with the aim of reutilizing the fuel core and zirconium can. The following operations have been studied: can hydrogenation (650-700°C, $P_{sub}(H_2)=15$ torr, duration-1 hour), separation of end products, vibrational de-canning (vibration frequency-9-17 oscillations per s., amplitude--1-3 mm, inclination-3-6 deg), grinding empty cans, deactivation of can fragments, degassing can fragments (800 deg C, vacuum-5×10^{-2} Torr), and re-melting fragments into ingots. This procedure makes it possible to use a major part of the salvaged fuel rods for reuse as fuel elements and can material.

11736 Plutonium, proliferation, and policy. Gilkinsky, V. (US Nucl Regul Comm). *Technol. Rev.;* **79**: No. 4, 58-65(Feb 1977).

The technological and political considerations underlying the storage, disposal and reprocessing of plutonium are presented. The need for regulatory authority at the international level is stressed, especially in connection with reactor fuels that have the potential for use as weapons.

11737 Studies for a comparison of the maximum possible consequences of accidents in a reprocessing plant and a nuclear power station. *Gut;* No. 2, 1-3(1977). (In German).

The article aims at comparing the danger potential of a commercial reprocessing plant with that of a large NPP. For doing this, the radiological effects of a so-called 'Super-MCA' were tested with no safety measures: melting of the fuel element receiving area and of the concentrate containers of a reprocessing plant and core meltdown. The tables contain the doses calculated for the critical organs for the distances 1, 10 and 100 km. The investigations demonstrate that there are no principal differences in the safety of a reprocessing plant and a NPP under those hypothetical pessimistic assumptions.

11738 International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977). 253p. (CONF-7605166—).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

This meeting was organized by the Canadian and U.S. Pugwash Groups. The main subject is placing reprocessing facilities under international or multinational control. Sixteen chapters are arranged under the following headings: general considerations, technical aspects, institutional arrangements, and political setting. Separate abstracts were prepared for ERA for all the chapters; no individual chapters were processed for EAPA. (DLC)

11739 Why reprocess. Greenwood, T. (Massachusetts Inst. of Tech., Cambridge). pp 17-29 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Prospective costs of reprocessing, waste management, and mixed oxide fuel fabrication have risen so much that the costs of U/P recycle and of spent fuel storage are nearly equal. This paper reviews the current state of the reprocessing industry, with a list of facilities all over the world, and examines the incentives and disincentives other than short-term economics that will affect the decision of states to acquire their own reprocessing facilities. Finally, it

examines the possibility of avoiding a widespread commercial reprocessing industry. (DLC)

11740 Technical and economic considerations in fuel reprocessing. Hatcher, S.R.; Morgan, W.W. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). pp 33-45 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

The uncertainties of the cost of building and operating reprocessing plants will only be reduced by actual experience. The technical processes have been reasonably well established but the whole operation is sensitive to political considerations which may impose costly delays and revisions of agreements. The extraction cost involves also the annual charges on capital which depend markedly on the method of financing by debt or equity and the applicable taxes. The increase of scale, from reducing the number of plants through multinational cooperation, promises cost advantages which, it is hoped, will more than offset the costs of reaching and maintaining the necessary agreements.

11741 Simple, uncertain economics of multinational reprocessing centers. Sharefkin, M. (Resources for the Future, Inc., Washington, DC). pp 47-64 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Absolute numbers mean little in themselves: what is the scale effect incentive—of the order of billions of dollars in present value—to be compared to. Compared to either the revenues or the net profits of the electric power industry, these sums are marginal. The statement can be made stronger: compared to the monetary value of feasible and well-understood utility-industry reforms, such as peak-load pricing, these sums are small. But this is neither a prediction that multinational reprocessing is improbable nor a suggestion that it is unimportant. The significant values at stake in issues of fuel-cycle governance are "benefit side" collective-good values. The valuation "problem" for these particular collective goods—insurance against the consequences of willful diversion, for example—make economic categories seem cumbersome and inappropriate. Here, as elsewhere, valuing collective goods is tricky business, and we should not be surprised if the issues are not settled on the "cost side." 8 tables.

11742 Safeguarding reprocessing facilities: the impact of multinationalization. Scheinman, L. (Energy Research and Development Administration, Washington, DC). pp 65-77 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Reprocessing facilities pose greater safeguards problems than other fuel cycle components. Reasons for the interest of many nations in developing a reprocessing capacity are explored. The present U.S. position on export of sensitive technologies is discussed. The problem of applying adequate safeguards at this point of the fuel cycle is next considered, including IAEA and bilateral arrangements. Arguments for and against multinational ownership or control of reprocessing facilities from the safeguards standpoint are discussed. (DLC)

11743 Safety considerations of nuclear-fuel reprocessing plants. Farmer, F.R. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 95-101 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Preconditions for international safety provisions are: (1) the problems should be well understood, with the highest degree of technical understanding; (2) rules should not be made prematurely; and (3) the nuclear risks should be seen in relation to other risks in modern society. This paper is addressed to the possible consequences of accidents in a reprocessing plant, compares these with the "safety" reports for reactor installations, and comments on some aspects of risk assessment and licensing in a multinational situation. (DLC)

11744 Regional fuel-cycle centers: technical and operational considerations. Dyne, P.J.; Lyon, R.B.; McLean, D.R. (Dept. of Energy, Mines and Resources, Ottawa). pp 103-109 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

The timing and logistics of establishing a reprocessing industry in Canada are discussed. Incentives for countries to organize a regional center and some of the technical, organizational, and political matters that would have to be resolved are reviewed. Disposal of radioactive wastes, safeguard standards, and choice of host country are all considered. (DLC)

11745 Institutional arrangements for a multinational reprocessing plant. Smith, C.B.; Chayes, A. (Harvard Law School, Cambridge, MA). pp 145-176 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

The paper lists some of the major issues that would have to be faced in negotiating the institutional structure of a multinational nuclear-fuel center. None of the organization problems is inherently insoluble. Difficulties are exacerbated by the large number of questions, their interrelations, and the complexity of the assumed structure. However, the assumptions posed the most difficult case. A reduction in membership and in the ambitious scope of the enterprise, at least at the outset, would greatly reduce the complexity of the organizational structure and the difficulty of negotiations. The analysis suggests that multinational fuel-cycle activities should start out more modestly, perhaps only with joint appraisal by a relatively few countries with existing geographic or economic connections. If operations are contemplated it would seem that the first step should be joint arrangements for spent-fuel storage, with the decision to go forward to more elaborate activities deferred. This approach would not only be simpler and permit the parties to gain experience working together, but it would have the virtue of delaying reprocessing until it was clear that there was a real need for it. Even on this reduced basis, the negotiating task would not be easy. The key, of course, to overcoming difficult technical problems of institutional structure is politial will—the genuine commitment of the participants to the aims and values of the enterprise. This suggests that any effort to cajole—not to say coerce—participation in a multinational fuel-cycle enterprise would be wholly misplaced. A reluctant partner would have available an infinitude of points and issues to create plausible, irritating, and ultimately defeating delay and complication in the negotiating process. Only assent freely given in the perception that the enterprise really serves the interest of the countries involved will be able to surmount the many institutional problems that will inevitably arise.

11746 Some experiences in formation and operation of multinational uranium-enrichment and fuel-reprocessing organizations. Allday, C. pp 177-187 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Three main points emerge from the experience gained in the formation and operation of United Reprocessors GmbH and Urenco/Centec: (1) The time scale involved in the formation and operation of these organizations is protracted partly because of the fact that more than one shareholder and government are involved, but also because some of the shareholders themselves have shareholders who have to be consulted on matters of particular importance. (2) Very careful consideration has to be given to the extent of the autonomy and independence of the joint organization. For Urenco/Centec and United Reprocessors it has proved to be more practicable for the shareholders to take the role of working partners. (3) Finally, when several technologies of virtually equal merit exist within a joint organization, it is very difficult, if not impossible, to make the decision to develop only one of them. In the case of Urenco/Centec each shareholder is responsible for its own development program but judges it in the light of complete and free exchange of information.

11747 Role of the IAEA in multinational fuel-cycle centers. Fischer, D.A.V. (International Atomic Energy Agency, Vienna). pp 189-199 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

In late 1974, IAEA made a preliminary study of the economic benefits of reprocessing and waste management at a regional center. A regional center project was launched in Sept. 1975; it is divided into four phases: mathematical model and code development, testing of the model and code, report, and adaption to specific regions. Incentives and disincentives for participation are discussed. The time

scale required to bring a multinational center into operation is considered. Safeguards and nonproliferation advantages of such a center are discussed. (DLC)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 12165

11748 Transport of irradiated fuel elements and radioactive waste. Keese, H. (Transnuklear G.m.b.H., Hanau (Germany, F.R.)). *At. Strom;* **23**: No. 1, 12-15(Jan 1977). (In German).

The author describes the types of transport with which we have to deal in the nuclear industry. In his discussion he pays special attention to the transport of irradiated fuel elements from the nuclear power station to the reprocessing plant, as well as the removal of the radioactive waste from fuel-element fabrication, the nuclear power station and the reprocessing via intermediate steps to the final storage.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 11703, 11733, 12565

11749 Economic model of the U.S. uranium mining industry. Ahmed, S.B.; Row, T.H. (West Ky Univ, Bowling Green). *IEEE Trans. Syst., Man, Cybern.;* **SMC-7**: No. 4, 236-243(Apr 1977).

The rapid increases in uranium prices in recent years have raised questions in the minds of the public and the utility industry concerning the expected cost of nuclear fuel for the reactors which are planned for commercial operation in the early 1980's. The economic advantage of nuclear plants has been primarily in the area of the fuel cost component of the electric power generation costs. The future trends in the nuclear fuel cycle costs are sensitive to the changes in uranium prices and enrichment costs. The purpose of this paper is to develop an economic model for the U.S. uranium mining industry for economic forecasts of uranium prices for the period 1975-2000. The model is designed to calculate the sensitivity of uranium prices with respect to the factors affecting uranium supply, demand, and prices of alternate fuels. 14 refs.

11750 Uranium exports could match oil imports. McIntyre, H.C. *Can. Chem. Process.;* **61**: No. 4, 20-23(Apr 1977).

Apart from a temporary embargo while safeguards are negotiated, the Canadian government limits uranium exports so as to guarantee fuel for every Canadian reactor built or planned for 30 years. On the basis of present known reserves of 172 Gg of 'cheap' U_3O_8 and 33 of 'dear', that would mean phasing out exports after the mid 1980's, but probably much more 'dear' uranium remains to be discovered. Provincial taxation and restrictions on foreign ownership may be limitations. Discoveries range over eleven areas, but production capacity at present is 14190 Mg/d from Ontario and 3400 from Saskatchewan, with 8800 mothballed and 4860 planned or being rehabilitated. The price has jumped to $95/kg, so that uranium exports may cover half the cost of oil imports. All producers use sulfuric acid leaching, except Eldorado, which uses carbonate leaching; a process using tertiary amine is being developed. Development of the organic-cooled Th/^{233}U fuelled reactor may greatly extend fuel resources.

11751 European needs for uranium in relation to world supply and demand. Davis, M. (Commission of the European Communities, Brussels (Belgium)). pp 1-7 of In Geology, mining, and extractive processing of uranium. Jones, M.J. (ed.). London; Institution of Mining and Metallurgy (1977).

From Symposium on the geology, mining and extractive processing of uranium; London, UK (17 Jan 1977).

See CONF-770146—.

The paper explains why Western Europe, and in particular the European Community, is engaged in an important diversification of energy sources to nuclear generated electricity. The resulting Western European demand for uranium (most of which will have to be imported) is quantified and discussed in relation to the needs of North America and Japan and the latest estimates of world uranium resources and production capability. The European Community will be the largest purchaser of uranium from a variety of sources on the world market. It is shown that the lower limits of past estimates for uranium demand appear to be the most reliable so far; the causes and effects of uncertainty for the future are outlined; and the need for exploration is emphasized. It is maintained that although close collaboration between electricity utilities and mining companies is highly desirable, the goal of an orderly market (which should be achievable for uranium) will not be achieved without a positive and constructive contribution being made by public authorities.

11752 First law of uranium dynamics. De Bruin, H.J. (Flinders Univ. of South Australia, Bedford Park). *Int. J. Heat Mass Transfer;* **1**: No. 3, 233-248(1977).

An embargo on the export of Australia's vast uranium mineral resources has been in force for several years. Pressures to lift the embargo are mounting. A Royal Commission has enquired into all aspects of uranium mining and exports. This paper, modified to some extent forms part of a submission to this enquiry. It is suggested that nuclear power be accepted as an interim solution to the world's energy problems. The plutonium fuelled breeder technology as the ultimate solution is rejected. Meanwhile the striking of a $750 (Australian) export levy per tonne of U_3O_8 will provide the funds for research and development in the use of renewable energy sources. Restrictive conditions imposed on the scale of uranium minerals and their beneficiated derivatives include guarantees against the separation of plutonium and the development and use of a plutonium technology.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 11736

11753 (BNWL—2117) **Proceedings of an actinide-sediment reactions working meeting.** Ames, L.L. (ed.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1976. Contract EY-76-C-06-1830. 575p. (CONF-760214—). Dep. NTIS, PC A99/MF A01.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

Separate abstracts were prepared for seven sections of this report. Abstracts of two papers appeared previously in ERA.

11754 Principles of provision concerning the back-end of the fuel cycle of nuclear power plants find application. *Umwelt (Inf. Bundesminist. Innern);* No. 57, 62-64(Jul 1977). (In German).

The Ministry of the Interior has asked the Laender on the 14th June 1977, to apply forthwith the 'principles of provision concerning the back-end of the fuel cycle of nuclear power plants' as a minimum pre-condition for waste management in licensing procedures for nuclear power stations. The 'principles' were part of a report, elaborated by a Bund/Laender working group at a undersecretary-of-state level on questions concerning the back-end of the fuel cycle of nuclear power plants. The report was favourably acknowledged during a meeting of the Federal Chancellor and the Minister-Presidents of the Laender on May 6th, 1977. The principles are presented.

11755 Legal aspects of waste management for nuclear power plants. Pelzer, N. (Goettingen Univ. (Germany, F.R.). Inst. fuer Voelkerrecht). *Atomwirtsch., Atomtech.;* **22**: No. 7, 393-396(Jul 1977). (In German).

The planned erection of a wast management center for nuclear power plants in the Federal Republic of Germany, which will include both a facility for reprocessing spent nuclear fuel and a waste storage facility for radioactive waste, poses numerous legal problems for which no final clarification has yet been found. This contribution above all deals with the concept of waste management and the problems attached to it, and with legal problems of the utilization of radioactive residues and the disposal of radioactive waste.

11756 Reusable frame greenhouse that saves money and erection time and reduces waste generation. Greenhalgh, W.O.; Ott, D.T. (Hanford Eng Dev Lab, Richland, Wash). *Nucl. Technol.;* **34**: No. 1, 111-113(Jun 1977).

An improved greenhouse design has been proposed and tested for use at the Hanford Engineering Development Laboratory for containing radioactive materials during decontamination, maintenance, and remodeling operations in nuclear facilities. The advantages of the greenhouse design include a reusable frame that is free standing and self-supporting and a plastic enclosure that is easily erected and attached to the frame. Manpower requirements appear to be about half that of the conventional greenhouse, the construction costs are approximately 20 to 40% lower, and the waste generated from the greenhouse is approximately 60% lower.

11757 R+D for the waste management concept of the Federal Government. Boehm, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 4, 186-190(Apr 1977). (In German).

A survey is presented of the problems and tasks concerning nuclear waste management. The various waste disposal steps (reprocessing, conditioning of radioactive wastes, and final storage) are described. The quantities of fuel elements and radioactive waste to be expected are stated. The research and development activities related to waste management, carried out almost exclusively by the centres, are discussed in detail.

WASTE PROCESSING

REFER ALSO TO CITATION(S) 11732, 11734

11758 (BNWL—2117, pp 11-38) **Disposal forms for the actinide wastes from the nuclear fuel cycle.** Mendel, J.E. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

The paper concerns the actinides produced in the generation of nuclear power, which are handled mostly by private industry. The distribution of actinides in the fuel cycle is described. Candidate solid forms for long-term immobilization are discussed. Factors potentially affecting long-term stability of HLW glasses include devitrification, radiation doses, metamictization, and leaching. Acceleration of alpha doses and extrapolation of leach rates to long times are studied. 6 figures, 6 tables, 10 references. (DLC)

11759 (BNWL—2274) **Evaluation of a precipitation-ion exchange process for treatment of laundry waste.** Mercer, B.W.; Ames, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 15 Mar 1977. Contract EY-76-C-06-1830;EY-76-C-06-2130. 60p. Dep. NTIS, PC A04/MF A01.

Bench-scale pilot plant studies were conducted to evaluate chemical coagulation and ion exchange for decontamination of 2724-W laundry wastewater. Chemical coagulation is accomplished at pH 11 to avoid complexant problems and assure good transuranic radionuclide removals. Clinoptilolite is used to remove cesium and strontium. Results of the pilot plant studies are summarized as follows: Decontamination factors of 70 (strontium) and more than 100 (cesium) were achieved by chemical coagulation and ion exchange. Decontamination factors exceeding 90 were measured for europium by coagulation with a combination of ferric chloride, magnesium chloride, and calcium chloride added to the wastewater at pH 11. Coagulation with these three agents in the wastewater at pH 11 was more effective for turbidity removal than coagulation with lime. Addition of up to 1.7 lb of clinoptilolite fines per 1000 gallons of wastewater during coagulation did not substantially increase strontium and cesium removal. Filtration without chemical coagulation reduced suspended solids by only 25%. About 70% of the suspended solids remaining in the filtered wastewater were removed in the zeolite column causing plugging which could not be easily dislodged by backwashing. Plugging of the ion exchange columns by previously clarified wastewater required short periods of limited backwashing to relieve the plug. The plugging is due to $CaCO_3$ and is not expected to be a severe problem in a full-scale plant with brief detention times between filtration and ion exchange. A high pressure surface wash should be included in the columns to break up crust or plugs at the surface of the zeolite. Centrifugation of iron sludges for 2 min at 2000 g reduced the sludge volume to about 1% of the total wastewater volume. Wet iron sludges from the sludge storage tank were readily dewatered by vacuum filtration. 14 tables, 9 figures.

11760 (CONF-770912—2) **Summary of the ORNL-sponsored reactor radwaste management workshop.** Kibbey, A.H. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

From ASME-IEEE joint power generation conference; Los Angeles, CA, USA (18 Sep 1977).

On January 12 to 14, 1977, Oak Ridge National Laboratory (ORNL) sponsored a Radwaste Management Workshop in New Orleans, Louisiana, the object of which was to obtain operating data on the uses of evaporation, ion exchange, filtration, and on solid radwaste practices at nuclear power plants. The collected data are being used to update three earlier generic reports done by ORNL on the status of evaporation, ion exchange, and solid radwaste practices at nuclear power plants and to prepare a new one on filtration. All segments of the nuclear power industry were invited to participate, and a total of 188 representatives came. There were four major Workshop groups: volume reduction, solidification, physical and chemical separations, and corrosion. The major findings of each group are reported. (LK)

11761 (Juel—1392) **Risk evaluation of a model of a high-level waste solidification plant.** Bruecher, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemische Technologie; Technische Hochschule Aachen (Germany, F.R.)). Feb 1977. 116p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

In this report the risk associated with the operation of a plant for vitrification of high-level liquid waste is evaluated. Considering risk assessment it turns out that the important accidents occur during off-gas cleaning. On the other hand effects of explosions in the process equipment don't contribute very much to the overall risk. These data are compared with the risk resulting from routine discharge of the plant. It is of the same magnitude as or greater than the most important accident risks.

11762 (MLM—2464) **Development of ultrafiltration and inorganic adsorbents for reducing volumes of low-level and intermediate-level liquid waste: April—June 1977.** Koenst, J.W.; Herald, W.R.; Roberts, R.C. (Mound Lab., Miamisburg, Ohio (USA)). 14 Nov 1977. Contract EY-76-C-04-0053. 13p. Dep. NTIS, PC A02/MF A01.

Ultrafication (UF) membranes have demonstrated 90 to 98% rejection of gross alpha in laboratory tests. In the treatment of laundry wastes, rejection of activity ranged from 98 to 99.9% gross alpha. The pilot UF system was installed and started up. Flux decline curves and volume reduction performance were determined. Volume reductions of 210 : 1 were achieved at flux rates of 1.1 gal/min (system is rated at 2 to 3 gal/min, 90% recovery) at activity rejection of 99.94% gross alpha. Adsorbent studies demonstrated capacities in excess of 10^9 dis/min/g for uranium-233 and in excess of 10^8 dis/min/g for plutonium-238. Construction and start-up of the Engineering Test Facility has been completed.

11763 (ORNL-tr—4422) **Treatment of low-activity liquid wastes by co-precipitation at the Saclay Nuclear Studies Center.** Cerre, P.; Mestre, E.; Bourdrez, J. 1965. Translation of Paper SM-71/57 by S.D. Blalock, Jr. (CONF-651202—50). 14p. Dep. NTIS, PC A02/MF A01.

From Symposium on practices in the treatment of low and intermediate level radioactive waste; Vienna, Austria (6 Dec 1965).

Ten years' experience of operating the low-activity liquid effluent treatment plant at Saclay has led to improvements and modifications of the treatment cycle. Among these, the authors consider certain aspects of flocculation, and in particular techniques for solidifying sludge. The increasing specific activity and volume of effluent requiring processing made it necessary to perfect the techniques employed, to provide greater protection and, above all, to complete the effluent treatment cycle by devising a means of handling the sludge resulting from the treatment itself. Apart from its increasing specific activity this sludge consists of 80% water. These two factors necessitate a reappraisal of the problem of handling and storing the concentrates, and the paper describes in detail modifications to the plant affecting principally: (i) remote control of the valves; (ii) settling and filtration; and (iii) solidification and final packaging of the sludge. The operating results are also analyzed, thus throwing light on the economic aspects of the problem.

11764 (RFP—2693) **Fluidized bed incineration of transuranic contaminated waste.** Ziegler, D.L.; Johnson, A.J. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 1976. Contract EY-76-C-04-3533. 12p. Dep. NTIS, PC A02/MF A01.

A 9 kg/h pilot scale fluidized bed incinerator is now being used for burning various types of radioactive waste at Rocky Flats Plant. General solid combustible waste containing halogenated materials is burned in a fluidized bed of sodium carbonate for in stu neutralization of thermally generated acidic gases. A variety of other production related materials has been burned in the incinerator, including ion exchange resin, tributyl phosphate solutions, and air filters. Successful operation of the pilot plant incinerator has led to the design and construction of a production size unit to burn 82 kg/h of plant-generated waste. Residues from incinerator operations will be processed into glass buttons utilizing a vitrification plant now under development.

11765 **Fission gas separation in reprocessing with the help of evaporation equilibrium data of the system nitrogen-argon, nitrogen-krypton und krypton-xenon.** Mastera, S.; Bohnenstingl, J.; Laser, M.; Merz, E. *Brennst.-Waerme-Kraft;* **29**: No. 5, 214-217(Mar 1977). (In German).

The rare-gas isotopes krypton and xenon which are formed as byproducts of nuclear fission and developed on re-processing, enter the waste gases and have to be separated by cryogic methods in order to reduce the radiologic loading of environments and similar effects. For this purpose it is necessary to know the liquidus lines and equilibrium data of these materials. The article describes how to determine these characteristic values for the system couples Ar-N_2 at temperatures between 115 and 175 K, for Kr-N_2 at temperatures between 100 und 125 K and for Xe-Kr at temperatures between 150 and 170 K.

11766 **Conditioning radioactive wastes by means of thermosetting resins.** Auboing, G.; Limongi, A.; Thiery, D. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Protection et des Etudes d'Environnement); Baer, A.; Buchwalder, M. (Novatome Industries, 92 - Le Plessis-Robinson (France)). *Rev. Gen. Nucl.;* No. 6, 501-507(Dec 1976). (In Frenh).

The principle of the conditioning process of low and medium activity wastes by means of thermosetting resins is described. The two major phases of its application, viz: pre-treatment and coating are analysed. Finally as an example, the plant where this conditioning process is put into application (currently in operation at the Nuclear Study Center of Grenoble) is described.

11767 **Bituminization of radioactive waste of low and moderate activity. The French operations.** Lefillatre, G. (CEA Centre d'Etudes

Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service de Chimie Appliquee). *Rev. Gen. Nucl.;* No. 6, 496-500(Dec 1976). (In French).

French operations concerning the bituminization of radioactive wastes produced by light water reactors, the direct bituminizing without preconcentration of liquid effluents, the experimentation for 18 months with the land burial of evaporation concentrates solidified by bitumen into blocks of 100 l are presented. The knowledge acquired in Valduc and in Saclay with facilities equipped with thin film evaporators and in Marcoule with the conditioning of trilaurylamine and tributylphosphate is mentioned. The future bituminizing facility in Cadarache, designed starting in 1977, is succinctly described.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 11753, 13073, 13087

11768 (BNWL—2117, pp 1-9) **U.S. geologic storage program.** Burkholder, H.C. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

11769 (BNWL-SA—6068) **Safety assessment of geologic repositories for nuclear waste.** Bartlett, J.W.; Burkholder, H.C.; Winegardner, W.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1977. Contract EY-76-C-06-1830. 27p. (CONF-770625—5). Dep. NTIS, PC A03/MF A01.

From International conference on nuclear systems reliability engineering and risk assessment; Gatlinburg, TN, USA (20 Jun 1977).

Consideration of geologic isolation for final disposition of radioactive wastes has led to the need for evaluation of the safety of the concept. Such evaluations require consideration of factors not encountered in conventional risk analysis: consequences at times and places far removed from the repository site; indirect, complex, and alternative pathways between the waste and the point of potential consequences; a highly limited data base; and limited opportunity for experimental verification of results. R and D programs to provide technical safety evaluations are under way. Three methods are being considered for the probabilistic aspects of the evaluations: fault tree analysis, repository simulation analysis, and system stability analysis. Nuclide transport models, currently in a relatively advanced state of development, are used to evaluate consequences of postulated loss of geologic isolation. This paper outlines the safety assessment methods, unique features of the assessment problem that affect selection of methods and reliability of results, and available results. It also discusses potential directions for future work.

11770 (DP-MS—77-37) **Use of naturally occurring helium to estimate ground-water velocities for studies of geologic storage of radioactive waste.** Marine, I.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract EY-76-C-09-0001. 22p. (CONF-771124—1). Dep. NTIS, PC A02/MF A01.

From Geological Society of America meeting; Seattle, WA, USA (7 Nov 1977).

In a study of the potential for storing radioactive waste in metamorphic rock at the Savannah River Plant near Aiken, South Carolina, the rate of water movement was determined to be about 0.06 m/y by analyzing gas dissolved in the water. The gas contained up to 6 percent helium, which originated from the radioactive decay of natural uranium and thorium in the crystalline rock. The residence time of the water in the rock was calculated to be 840,000 years from the quantity of uranium and thorium in the rock, their rates of radioactive decay, and the quantity of helium dissolved in the water. The estimation of ground-water velocities by the helium method is more applicable to the assessment of a geologic site for storage of radioactive waste than are velocities estimated from packer tests, pumping tests, or artificial tracer tests, all of which require extensive time and space extrapolations.

11771 (ERDA—77-44) **Alternatives for long-term management of defense high-level radioactive waste, Hanford Reservations, Richland, Washington.** (Energy Research and Development Administration, Washington, D.C. (USA)). Sep 1977. 309p. Dep. NTIS, PC A14/MF A01.

The objective of this document is to provide information or alternatives that are being considered for the long-term management of defense high-level radioactive waste stored at Hanford in underground tanks and in stainless steel-lined concrete basins. For purposes of basic programmatic decision making, four major alternatives based on disposal location are considered. The steps leading to placement of the waste in the following locations are illustrated: existing waste tanks; onsite engineered surface facilities; onsite geologic repository; and offsite geologic repository. The four major disposal alternatives are expanded into 27 alternative plans by considering: (1) variations in the final form of the high-level fraction (with radionuclide removal) to include glass, concrete, and powder; (2) variations in the final form of the dehydrated waste product to include glass, calcined clay, and powder; and (3) variations in the treatment and handling of encapsulated waste to include packaging of capsules in canisters and conversion of the strontium fluoride and cesium chloride to glass; canisters stored in sealed casks on the surface are disposed of in a surface vault after the radionuclides have decayed sufficiently to avoid a heat-transfer problem. A description of the technology, a preliminary risk assessment, and preliminary cost estimates for each of these 27 plans are presented. The technology required to implement any of the 27 alternative plans has not been developed to the point where any plan can be considered completely technically sound and feasible.

11772 (KFK—2422) **Investigations on the long-term radiation stability of borosilicate glasses against alpha-emitters.** Scheffler, K.; Riege, U. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle). Apr 1977. 23p. Dep. NTIS (US Sales Only), PC A02/MF A01.

By accellerated experiments with Cm-242- doped HLW glasses the long-range behaviour of borosilicate glasses during final disposal has been simulated. To cover those questions concerning long-term safety aspects the properties of these glasses have been investigated on a time-lapse scale corresponding to 10,000 years storage of real HLW borosilicate glasses. The effects of radiation on structure, helium buildup, mechanical strength, energy storage and leachability of the glasses have been studied.

11773 (LA—6856-PR) **Development activities on shallow land disposal of solid radioactive waste. Progress report, January—December 1976.** (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

Progress on projects focused on problems of shallow land burial of radioactively contaminated solid waste is summarized. Developments on a system to evaluate the containment adequacy of existing burial sites are described. Efforts to describe the environmental factors in monitoring the LASL disposal sites are discussed. The aim of a new program on radioactive waste burial technology is outlined.

11774 (Y/OWI/SUB—77/16535/3) **National waste terminal storage program: configuration management plan. Volume I. Management summary.** (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). May 1977. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

Objective of the Configuration Management Plan is to describe the Office of Waste Isolation's approach for the systematic identification, change control, status accounting, and auditing of: documents defining the NWTS Program and the plans for attaining the defined objectives; physical and functional characteristics of each storage site, facility, systems and equipment; and associated costs and schedules.

11775 (Y/OWI/TM—28) **Trip report: workshop on risk analysis and geologic modeling in relation to the disposal of radioactive wastes into geological formations.** Claiborne, H.C. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 1977. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

The Workshop was co-sponsored by the Commission of European Communities (CEC) and the Office of Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA), with primary object being to promote international cooperation in developing and using risk assessment techniques for the long-term safety assessment of waste disposal. The attendance was restricted to specialists in the field and a few observers; 43 people were in attendance representing 14 different countries. Nothing particularly new or novel was presented nor any formal cooperation agreed upon. However, there was a feeling that continued informal cooperation was helpful and should be continued. Greater or lesser degrees of formality could be decided later. The U.S. program was definitely more advanced and larger in scope than the others that were discussed. Countries that seemed to have significant programs include the Federal Republic of Germany, France, Canada, Sweden, and the CEC. Abstracts of papers are presented together with consensus reports on containment failure modes and geosphere transport modeling.

11776 **Storage of radioactive material.** Richards, L.M. (to Atlantic Richfield Co.). US Patent 4,040,480. 9 Aug 1977. Filed date 15 Apr 1976. 8p.

Containers of radioactive material are placed in a well, so that the subterranean well lining absorbs much of the radiation from the containers. The heat generated by the radioactive material is transferred through the wall of the container through the wall of a vertically disposed heat tube having a cavity containing both water

and water vapor, through the metal wick on the internal wall, and to the liquid water. The thus generated water vapor and/or steam flows upwardly within the cavity of the heat tube into the heat dissipation zone, which is cooled by atmospheric air. Such cooling condenses the steam to liquid water which flows downwardly to the heat absorption zone. The walls of the heat tube have such a low corrosion rate that reliable performance after weathering for many decades is assured. Some water may be radiolytically decomposed by the radiations from the radioactive material. Canisters of water synthesis catalyst are positioned in the vapor space of the heat tube to recombine the hydrogen and oxygen generated by such radiolytic decomposition of water. The system achieves a maintenance-free arrangement for heat dissipation during a period of decades until the heat generation is low enough to permit cheaper storage, such as in a cavern having subterranean surfaces able to dissipate heat at a rate greater than the radioactive material then generates heat.

11777 HIP solution for nuclear waste storage. Anon. *Nucl. Eng. Int.;* **22**: No. 261, 38(Aug 1977).

The use of hot isostatic pressing for containment and storage of nuclear waste, under development in Sweden, is very briefly outlined. Three possible alternative techniques associated with different stages of the fuel cycle are referred to. The compacting process involves pressure sintering of alumina powder or, for high level liquid waste, titanium oxide powder, into a capsule, at very high temperatures and pressures.

11778 Secure storage of radioactive waste. Daw, G.; Williams, R. *Combustion;* **48**: No. 12, 24-32(Jun 1977).

Among the several processes avilable for nuclear waste disposal, the most attractive alternative, according to the authors, is a system that converts high-level liquid waste to a solid and immobilizes it in glass. Ultimate disposal, retrievably or permanently, would be in stainless steel casks deposited in vaults that are cut into deep, dry, stable geologic structures such as granite, desert soil, or salt. This method is attractive both because the technology is available today and because it would require less time than other methods to carry it to commercial scale. The sequence of the process is detailed.

11779 Possibility of triggering earthquakes by injection of radioactive wastes in shale at Oak Ridge National Laboratory, Tenn. Sun, R.J. *J. Res. U.S. Geol. Surv.;* **5**: No. 2, 253-262(1977).

Conditions for producing earthquakes by fluid injection are (1) underlying rock stressed to the verge of fracturing by tectonic stresses and/or on the brink of sliding on pre-existing fault planes, (2) the presence of potentially active faults, and (3) an increase of pore pressure in the rock caused by fluid injection or seepage from reservoir(s). The mechanism of disposal of radioactive wastes in shale by grout injection and hydraulic fracturing used at ORNL is different from injection of fluid. The injected grout is in its liquid phase only during the injection period and hopefully confined in the hydraulically induced bedding-plane fractures. The grout is then allowed to solidify under pressure after termination of the injection, and, after solidification, it becomes an integral part of the shale. Significant characteristics of the disposal method and the site are as follows: (1) Because of the low permeability of shale and high viscosity of the injection grout, pore pressure in the rock, does not increase due to the injections; the injected grout enters newly formed bedding-plane fractures, (2) the injection site is free of local faults and of major interconnected joints and fractures; accordingly, injected grout in its liquid state is expected to be confined principally in the induced nearly horizontal bedding-plane fractures, and (3) due to low tensile strength along shale bedding planes, the energy needed to induce bedding-plane fractures is small. An increase of pore pressure in rock and association with potentially active fault(s) do not occur at the proposed site at ORNL and that the disposal method does not produce an increase in pore pressure, it can be concluded that neither the method nor the site has the characteristics for triggering earthquakes during and after grout injections.

11780 Storing radioactive wastes in cooled pebbles. Lewis, W.B. (Queen's Univ., Kingston, Ont.). pp 111-123 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Two distinct methods have been proposed for the safe management of radioactive wastes: one seeks to avoid water (storage in an ancient salt bed, etc.), while the other employs groundwater to cool wastes in glass pebbles. A small-scale demonstration of the second method has been underway at Chalk River for more than 15 years, and the radioactivity levels in the groundwater have been below the ICRP MPCs for public drinking water. ^{239}Pu, ^{90}Sr, and radium and its daughters are discussed. The extremely slow migration of helium from thorianite and of fission products in the Oklo phenomenon is pointed out. A chart of atomic mobility in solids is included. Retrieval and recycling of major fuel components are discussed. (DLC)

11781 Off-shore discharge of radioactive wastes. Olivier, J.P. (Nuclear Energy Agency, 75 - Paris (France)). *Rev. Gen. Nucl.;* No. 6, 513-519(Dec 1976). (In French).

After having the balance schedule of the off-shore discharge of radioactive wastes carried out as from 1946, the results of numerous studies made in order to estimate the possible consequences of radioactive contamination of the sea on sea organisms and man are analyzed. The requirements and legal conditions adopted internationnally which guarantee preparation and carrying out of waste discharge operations under sufficient safety conditions are quoted. Finally the long term prospects of this waste storage method are evoked.

11782 Radioactive materials. The present status of investigations related to various categories of pollution in the marine environment. Sugiura, Y. (Meteorological Research Inst., Tokyo (Japan)); Shimizu, M. *Nippon Kaiyo Gakkaishi;* **1975**: 33-40(Oct 1975). (In Japanese).

The problems of radioactivity in the ocean with marine life are various. Activities in this field, especially the measurements of the radioactivity in sea water and marine life are described. The works first started in Japan concerning nuclear weapon tests. Then the port call to Japan by U.S. nuclear-powered naval ships began. On the other hand, nuclear power generation is advancing with its discharge of warm water. The radioactive pollution of sea water, and hence the contamination of marine life are now major problems. Surveys of the sea areas concerned and study of the radioactivity intake by fishes and others are carried out extensively in Japan.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 12913, 13067, 13068

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 11725, 11743, 13069

REGULATIONS

11783 (ORNL/TM—6036) **Preliminary analysis of alternative fuel cycles for proliferation evaluation.** Steindler, M.J.; Ripfel, H.C.F.; Rainey, R.H. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 240p. Dep. NTIS, PC A11/MF A01.

The ERDA Division of Nuclear Research and Applications proposed 67 nuclear fuel cycles for assessment as to their nonproliferation potential. The object of the assessment was to determine which fuel cycles pose inherently low risk for nuclear weapon proliferation while retaining the major benefits of nuclear energy. This report is a preliminary analysis of these fuel cycles to develop the fuel-recycle data that will complement reactor data, environmental data, and political considerations, which must be included in the overall evaluation. This report presents the preliminary evaluations from ANL, HEDL, ORNL, and SRL and is the basis for a continuing in-depth study. (DLC)

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 11738, 11742, 12265

11784 (UCRL—79615) **Accountability methods for plutonium and uranium: the NRC manuals.** Gutmacher, R.G.; Stephens, F.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Sep 1977. Contract W-7405-ENG-48. 9p. (CONF-771048—4). Dep. NTIS, PC A02/MF A01.

From 21. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (4 Oct 1977).

Four manuals containing methods for the accountability of plutonium nitrate solutions, plutonium dioxide, uranium dioxide and mixed uranium-plutonium oxide have been prepared by us and issued by the U.S. Nuclear Regulatory Commission. A similar manual on methods for the accountability of uranium and plutonium in reprocessing plant dissolver solutions is now in preparation. In the present paper, we discuss the contents of the previously issued manuals and give a preview of the manual now being prepared.

11785 Tail end of the fuel cycle: coping with the Carter ediet. Olds, F.C. *Power Eng.;* **81**: No. 8, 38-46(Aug 1977).

President Carter's unilateral attempt to achieve a worldwide moratorium on reprocessing, recycle, and breeder development has had a cold reception. The U.S. alone appears to honor the moratorium, and its prestige suffers as the bill of particulars against the plan takes form. Isotopic denaturing of plutonium fuel, however, is a

promising new means for rendering the fuel cycle highly diversion-resistant. In this process the fissile isotopes of plutonium would be tied almost inseparably into a chain of fertile isotopes. This renders the material unsuitable for weapons and difficult to handle outside of the fuel cycle. For isotopic denaturing to be most effective, it should be instituted as widely as possible, throughout the world. This requires a number of procedural, political, and international policy measures. In short, the nuclear power nations need to agree on the use of denatured fuel, and to restrict export reactors to those using denatured fuel.

11786 Nuclear fuel cycle and nuclear proliferation. Rathjens, G.W. (Massachusetts Inst. of Tech., Cambridge); Carnesale, A. pp 3-15 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Six nations have detonated nuclear explosives, and other nations may feel pressured to follow suit. This paper examines the courses such a nation might pursue and the range of alternatives available for generating counter pressures in the acquisition of national reprocessing or enrichment facilities. Technical and economic factors relating the fuel cycle to the proliferation of nuclear weapons are discussed. Tests which any proposed solution must meet are outlined. (DLC)

11787 Impact of international safeguards arrangements upon nuclear-fuel-cycle operation. Beets, C. (CEN, Mol, Belg.). pp 79-93 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Partition of the risks between safeguards systems and physical protection systems is discussed. Implementation of international safeguards in the European fuel fabrication and reprocessing facilities is described. Accounting performance will be further improved in future high-throughput installations, when real-time accountancy and continuous sampling are introduced. Farmer's preconditions (see following citation) are discussed, based on the analogy between the projected regional centers and structures of the European Community. (DLC)

11788 Physical security in multinational nuclear-fuel-cycle operations. Willrich, M. (Rockefeller Foundation, New York). pp 125-142 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Whether or not multinationalization will reduce or increase risks of theft or sabotage will depend on the form and location of the enterprise, the precise nature of the physical security arrangements applied to the enterprise, and the future course of crime and terrorism in the nuclear age. If nuclear operations are multinationalized, the host government is likely to insist on physical security measures that are at least as stringent as those for a national or private enterprise subject to its jurisdiction. At the same time, the other participants will want to be sure the host government, as well as criminal groups, do not steal nuclear material from the facility. If designed to be reasonably effective, the physical security arrangements at a multinational nuclear enterprise seem likely to reduce the risk that any participating government will seek to divert material from the facility for use in a nuclear weapons program. Hence, multinationalization and physical security will both contribute to reducing the risks of nuclear weapons proliferation to additional governments. If economic considerations dominate the timing, scale and location of fuel-cycle facilities, the worldwide nuclear power industry is likely to develop along lines where the problems of physical security will be manageable. If, however, nuclear nationalism prevails, and numerous small-scale facilities become widely dispersed, the problem of security against theft and sabotage may prove to be unmanageable. It is ironic, although true, that in attempting to strengthen its security by pursuing self-sufficiency in nuclear power, a nation may be reducing its internal security against criminal terrorists.

11789 International arrangements for nuclear-fuel-cycle facilities: the politics of the problem. Epstein, W. pp 233-245 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

Thirty years after the Three-Power Declaration on November 5, 1945, promising effective safeguards on the information exchange on atomic energy, many nations are selling and transferring nuclear materials, equipment, and technology without these "effective enforceable safeguards." Even though there is no actual commercial need to reprocess spent fuel into Pu, France and West Germany are planning to sell reprocessing plants to non-NPT countries. The erosion of faith in and the weakening of the NPT are pointed out. The Canadian decision not to resume nuclear aid to India is commended. The question of how effective and enforceable the international (IAEA/NPT) safeguards are, is addressed. The weaknesses of the London Suppliers' Club position on safeguards are pointed out. Multinational fuel cycle centers would not much help to contain the risks of nuclear proliferation. Additional measures needed for really effective safeguards are listed. The unilateral embargo of nuclear exports by U.S. is proposed. Political measures to discourage nations from acquiring nuclear weapons are also listed. Only a combination of political, psychological, and technical measures can produce an effective nonproliferation regime. (DLC)

11790 Application of the fuel-nondestructive analysis to plutonium fuel fabricating facilities. Tsutsumi, M. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Proc. Jpn. Conf. Radioisot.;* No. 12, 305-306(Jun 1976). (In Japanese).

From 12. Japan conference on radioisotopes; Tokyo, Japan (26 Nov 1975).

The nondestructive measuring instruments for nuclear fuel employed in nuclear fuel facilities are shown in five pictures. Picture 1 illustrates a calorimeter provided for measuring the plutonium contained in fuel pellets as well as the plutonium powder existing in facilities. Picture 2 shows an active neutron device, to which the neutron interrogation method is applied. Cf-252 is used as a neutron source. A sample holder moves while rotating to the detector end. Four plastic scintillators are built in the detector end to detect neutron beam and gamma-ray. The pulses from two or three detector ends are counted. This instrument is suitable particularly for the determination of a minute amount of plutonium and uranium in scraps. Picture 3 shows an active neutron device usually employed in uranium fuel fabricating plants. Picture 4 indicates a fuel rod scanner, to which gamma spectrometry is applied. The fuel rods having the different degree of enrichment of plutonium can be identified, and plutonium in one fuel rod is determined. Picture 5 indicates a passive neutron device which can determine the total amount of plutonium contained in a fuel assembly. More accurate and more reliable nondestructive measuring instruments are necessary to automate nuclear fuel processing facilities.

ADMINISTRATIVE AND REGULATORY

REFER ALSO TO CITATION(S) 12267, 12570

11791 Towards a comprehensive uranium fuel management policy for Australia. Crook, K.A.W. (Australian National Univ., Canberra. Dept. of Geology). *Search;* 8: No. 7, 223-231(Jul 1977).

A consideration of the problems inherent in the extraction and use of uranium fuels, in particular the long-term radiation hazard posed by wastes, leads to the recognition of several severe geological and social constraints that must govern any comprehensive management policy. In the light of these, and of the need to prevent diversion of nuclear material for the manufacture of weapons, the author outlines a comprehensive uranium fuel management policy for Australia. It is recommended that Australia's uranium should not be mined until the feasibility and cost of such a management policy have been assessed and compared with the added risks entailed in any less stringent management policy.

11792 Relevance of Intelsat experience for organizational structure of multinational nuclear fuel facilities. Skolnikoff, E.B. (Massachusetts Inst. of Tech., Cambridge). pp 223-230 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

The multinational fuel centers will be a much more difficult development than creating an international organization for communications satellites, but there are obvious parallels that can be used or avoided. The relative success and effectiveness of Intelsat gives hope that the task can be achieved.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 12774, 12775, 12776, 12777, 12778, 12779, 12780, 12781

ISOTOPIC POWER SUPPLIES

DESIGN AND FABRICATION

11793 (COO/2764—1) **Demonstration of a free piston Stirling engine driven linear alternator, phase I report.** Goldwater, B.; Piller, S.; Rauch, J.; Cella, A. (Mechanical Technology, Inc., Latham, N.Y. (USA)). 30 Mar 1977. Contract EY-76-C-02-2764. 204p. Dep. NTIS, PC A10/MF A01.

The results of the work performed under Phase I of the free piston Stirling engine demonstrator program are described. The objective of the program is to develop a 2 kW free piston Stirling engine/linear alternator energy conversion system, for an isotopic heat source, with a greater than 30% overall efficiency. Phase I was a 15-month effort to demonstrate the feasibility of the system through analysis and experimental testing of the individual components. An introduction to Stirling engines and the de*ails of the tasks completed are presented in five major sections: (1) introduction to Stirling engine; (2) preliminary design of an advanced free piston Stirling demonstrator engine; (3) design and test of a 1 kWE output linear alternator; (4) test of a model free piston Stirling engine; and (5) development of a free piston Stirling engine computer simulation code.

HYDROGEN

11794 (Juel-Conf—23, pp 218-225) **Hydrogen economy in the Belgian context.** Baetsle, L.H. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The lecture outlines general aspects of a hydrogen-based economy, the possible role of hydrogen for electricity storing, the supposed development of power generation in Belgium, the possibilities of substituting hydrogen for natural gas, and hydrogen production by electrolysis and thermal water splitting.

PRODUCTION

REFER ALSO TO CITATION(S) 11444, 11805

ELECTROLYSIS

11795 **Materials used in water photolysis techniques of solar energy conversion.** Haneman, D. (Univ of NSW, Kensington, Aust). *J. Aust. Inst. Met.;* **21**: No. 2-3, 112-113(1976).

Electron hole pairs are created by light in the semiconductor surface region, and are there separated by the surface region electric field. The holes (for an n type semiconductor with "upward" band bending) flow to the surface and capture electrons from OH$sup -$ species in solution. The electrons flow out from a metal counter electrode and neutralize H$sup +$ ions to produce hydrogen, a storable fuel. Inexpensive materials can be employed for the semiconductor anode and the metal cathode in the cell. The material studied most extensively to date is titania (TiO$sub 2$). It has one major drawback; the bandgap of approximately 3 eV means that only wavelengths less than about 400 nm can be used, which is only 3% of the incident solar power. A vigorous search for other materials is under way. Those tried include SrTiO$sub 3$, CdS, CdSe, SnO$sub 2$, KTaO$sub 3$, WO$sub 3$ Fe$sub 2$O$sub 3$, CdO, Si and GaP. Of these materials, Si, CdS and CdSe corrode, and Fe$sub 2$O$sub 3$ and GaP corrode in acid but not alkaline solution. It may be possible to prevent net CdS and CdSe dissolution by adding appropriate quantities of a sulphide (Na$sub 2$S) to the solutions. 4 refs.

THERMOCHEMICAL PROCESSES

11796 (Juel-Conf—23, pp 226-241) **Hydrogen production by water-splitting using heat supplied by a high-temperature reactor.** Courvoisier, P.; Rastoin, J.; Titiliette, Z. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

Some aspects of the use of heat of nuclear origin for the production of hydrogen by water-splitting are considered. General notions pertaining to the yield of chemical cycles are discussed and the heat balance corresponding to two specific processes is evaluated. The possibilities of high temperature reactors, with respect to the coolant temperature levels, are examined from the standpoint of core design and technology of some components. Furthermore, subject to a judicious selection of their characteristics, these reactors can lead to excellent use of nuclear fuel. The coupling of the nuclear reactor with the chemical plant by means of a secondary helium circuit gives rise to the design of an intermediate heat exchanger, which is an important component of the overall installation.

11797 (Juel-Conf—23, pp 242-243) **Thermochemical processes for water decomposition.** De Beni, G. (Commission of the European Communities, Ispra (Italy)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The short lecture reports on the present activities of the Ispra establishment of the EURATOM J.R.C. with respect to H_2 release by means of thermochemical water splitting. Work is done on sulphuric acid cycles incorporating, to some extent, an electrochemical process step.

11798 (LA—6970-PR) **Thermochemical processes for hydrogen production. Progress report, January 1—July 31, 1977.** Cox, K.E. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

The Thermochemical Hydrogen Program at the Los Alamos Scientific Laboratory is continuing its investigation of practical schemes to decompose water thermochemically for production of hydrogen. Current efforts were directed to experimental studies of reactions relevant to the sulfuric acid-hydrogen bromide thermochemical cycle. The use of insoluble bismuth sulfate as a means of concentrating aqueous sulfuric solutions is also under investigation. Preliminary calculations show a significant cycle efficiency increase if solid sulfate and subsequent sulfur trioxide decomposition steps replace the sulfuric acid concentration and decomposition steps proposed in other cycles.

11799 (LA-UR—77-2507) **LASL thermochemical hydrogen program status on October 31, 1977.** Cox, K.E.; Bowman, M.G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 7p. (CONF-771128—1). Dep. NTIS, PC A02/MF A01.

From Annual DOE chemical energy storage and hydrogen energy systems contract review meeting; Washington, DC, USA (16 Nov 1977).

The LASL Hydrogen Program is continuing its investigation of practical schemes to decompose water thermochemically for hydrogen production. Efforts were and are being devoted to process improvements in cycles that use sulfuric acid as an intermediate. Sulfuric acid-hydrogen bromide cycles are being studied as a means of overcoming the heat penalty in drying acid solutions. An alternate approach involves the use of insoluble bismuth sulfate that is precipitated from acid solution. Preliminary energy balances indicate a significant increase in cycle efficiency for both these options.

STEAM REFORMER PROCESSES

11800 **New steam-reforming process for high-boiling hydrocarbons.** Tomita, T. (Toyo Engineering Corp., Tokyo (Japan)); Kitagawa, M. (Tokyo Gasu K.K. (Japan)). *Chem.-Ing.-Tech.;* **49**: No. 6, 469-479(Jun 1977). (In German).

From 18. exhibition and conference of chemical apparatus. ACHEMA '76; Frankfurt am Main, Germany, F.R. (20 - 26 Jun 1976).

A new continuous steam-reforming process, the THR process, has been developed and successfully operated on a pilot plant scale since October 1973. Numerous hydrocarbons, including naphtha, crude oil, and atmospheric or vacuum residues can be gasified with the aid of the newly developed T-12 catalyst without any need for feed pretreatment, such as desulfurization or demetallation. Among the numerous conceivable applications of the THR process, hydrogen production from bunker C oil and production of clean fuel gas from crude oil have been examined and subjected to economic studies. It was found that the THR process is more economical than partial oxidation. Once the price ratio of naphtha to petroleum has passed a certain value, the THR process is more economical for production of clean fuel gas than conventional steam reforming.

11801 New steam-reforming process for high-boiling hydrocarbons. Tomita, T.; Kitagawa, M. (Toyo Eng Corp, Tokyo, Jpn). *Chem.-Ing.-Tech.;* **49**: No. 6, 469-475(Jun 1977). (In German with English abstract).

A new continuous steam-reforming process, the THR process, has been developed and successfully operated on a pilot plant scale since October 1973. Numerous hydrocarbons, including naphtha, crude oil, and atmospheric or vacuum residues can be gasified with the aid of the newly developed T-12 catalyst without any need for feed pretreatment, such as desulphuration or demetallation. Among the numerous conceivable applications of the THR process, hydrogen production from bunker C oil and production of clean fuel gas from crude oil have been examined and subjected to economic studies. It was found that the THR process is more economical than partial oxidation. Once the price ratio of naphtha to petroleum has passed a certain value, the THR process is more economical for production of clean fuel gas than conventional steam reforming.

STORAGE

REFER ALSO TO CITATION(S) 11805

CHEMISORPTION

REFER ALSO TO CITATION(S) 12824

11802 LaNisub(5-x)Alsub(x) is a versatile alloy system for metal hydride applications. Mendelsohn, M.H.; Gruen, D.M. (Argonne National Lab., Ill. (USA)); Dwight, A.E. *Nature (London);* **269**: No. 5623, 45-47(1 Sep 1977).

Metal alloys which reversibly absorb and desorb hydrogen are being used or considered for a variety of energy applications. Alloys of general composition AB_5 are prime candidates because of their good hydrogen absorption/desorption kinetics and large hydrogen storage capacity. The $LaNi_5$-H_2 system, in particular, has been extensively investigated. In many applications, however, materials are required whose plateau pressures are different from those of $LaNi_5$Hsub(6,7). The desorption pressure of $LaNi_5$Hsub(6,7) may be modified by substitutions either of La or Ni with other elements. Previous work has shown that 20% substitutions of Ni by a variety of transition metals can lower plateau pressures by a factor of approximately 4. It is reported here that Al can substitute for Ni in $LaNi_5$ with dramatic results in lowering decomposition pressures without impairing the kinetics or the hydrogen carrying capacities. The important new result is that Al substitutions allow a wide range of decomposition pressure to be spanned in continuous fashion. In the range 0 to 20% Al the the plateau pressures of the $LaNi_5$-$LaNi_4Al$ hydride system are reduced by a factor of approximately 300.

11803 Hydrogen storage method by metal hydrides, (2). Fukuda, Y.; Fujimura, T. (Japan Defence Agency, Tokyo. First Research Center). *Giho (Boeicho Gijutsu Kenkyu Honbu);* No. 656, 1-10(Jul 1976). (In Japanese).

Titanium iron alloys and RNi_5 alloy, which R was a mixture of rare-earth metals, reacted directly with hydrogen to form hydrides. The hydride of RNi_5 alloy was reported to absorb and desorb easily large quantities of hydrogen under relatively small pressure at room temperature, Pressure - composition isotherms were determined for the systems TiFesub(0.9)Hsub(0.1) -- TiFesub(0.9)Hsub(1.6) and RNi_5Hsub(0.3) -- RNi_5Hsub(6.3). Pertinent thermodynamic values were calculated for each system. The hydriding behavior of titanium iron alloys was sensitive to Ti/Fe ratios. Pressure - composition isotherms for TiFesub(1.2) - H system exhibited short plateau, but the isotherms for TiFesub(0.5) - H system no longer exhibited the plateau.

11804 Metal hydride storage for mobile and stationary applications. Hoffman, K.C.; Reilly, J.J.; Salzano, F.J.; Waide, C.H.; Wiswall, R H.; Winsche, W.E. (Brookhaven Natl Lab, Upton, NY). *SAE Prepr.;* No. 760569, 1-20(1976).

The iron-titanium and magnesium alloys are especially promising hydride storage media, the former in stationary applications, or where weight is not a limiting consideration, and the latter for mobile applications. Each of these materials has unique pressure-temperature characteristics and reaction kinetics which must be considered in the design of a hydrogen storage system. These special characteristics are discussed for particular applications. The results of recent work on hydrogen storage development and the engineering design of storage systems are reviewed. 22 refs.

CRYOGENIC

REFER ALSO TO CITATION(S) 12824

SAFETY

11805 Safety technique aspects of hydrogen technology. Pennings, P. (TUV Rheinland, Koeln, Ger). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 6, 230-235(Jun 1977). (In German).

Physical properties and production processes of hydrogen for industrial and transportation utilization are analyzed. Safety measures during storage, distribution, and transportation in liquid and gas form are discussed. Standards are explained regarding the need for a new comprehensive hydrogen code, mainly for fuel applications.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 11805, 12824

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 11996

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 11910

PROPERTIES

11806 (SAND—77-8722) **Comparison of Raman and thermocouple temperature measurements in flames.** Schoenung, S.M.; Mitchell, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 25p. (CONF-771015—10). Dep. NTIS, PC A02/MF A01.

From Fall meeting of the Western States Section of the Combustion Institute; Palo Alto, CA, USA (17 Oct 1977).

Temperatures in the post-flame regions of methane/air and ammonia/oxygen premixed flat flames have been measured employing state-of-the-art laser Raman spectroscopy and conventional thermocouple thermometry. Theoretically calculated N_2 $^1\Sigma$ and O_2 $^3\Sigma$ rotation-vibration Raman Q-branch spectra have been least squares fit to experimentally obtained intensities. The N_2 $^1\Sigma$ Q-branch was monitored in the CH_4/air flame. The temperatures determined by fitting the entire spectrum, including as many as five vibration bands, and by fitting only the spectral region about the first- and ground-state vibrational bands, differed by less than 2%. These were within 2% of the radiation-corrected thermocouple temperatures. Both the N_2 $^1\Sigma$ and the O_2 $^3\Sigma$ Q-branches were monitored in the NH_3/O_2 flame. Comparison of the experimentally obtained intensities and the calculated "best-fit" Raman Q-branch revealed that some laser-induced emission other than that due to Raman scattering was included in the measured intensities. This laser-induced emission varied with wavenumber and is believed to be due to NO_2 fluorescence. A linear relation which resulted in zero intensities outside the N_2 $^1\Sigma$ and O_2 $^3\Sigma$ spectral region was assumed for the laser-induced emission as a function of wavenumber. This laser-induced background was subtracted from the measured intensities. The temperatures determined from these "corrected" intensities exceeded the radition-corrected thermocouple temperatures by about 8%. Agreement between temperatures determined from the N_2 $^1\Sigma$ and O_2 $^3\Sigma$ Q-branches differed by less than 7%. Study results demonstrate the accuracy of Raman spectroscopy as a temperature measurement technique in flames and indicate the care which must be taken when analyzing experimentally obtained Raman vibrational Q-branch intensities in systems where fluorescence may be a problem.

PREPARATION

REFER ALSO TO CITATION(S) 11444

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 11440, 11455, 11693, 11801

11807 Process cuts methanation cost. Frank, M.E. (Chem Syst Inc, New York, NY). *Hydrocarbon Process.;* **56**: No. 7, 167-172(Jul 1977).

Methanation/shift to methane from coal gasification is most economically accomplished with the Liquid-Phase Methanation/

Shift (LPM/S) process currently being developed under ERDA/AGA sponsorship. Savings in the order of 6 to 25$cent$/MMBtu's are possible compared with other combinations of processing. The variation in savings depends upon the ratio of hydrogen to carbon monoxide in the coal gasifier synthesis gas and the financing approach employed by the company. Details of the process are given along with its advantages. It is demonstrated that combined methanation and shift conversion (in one common reactor) of synthesis gas from coal gasification products saves water and helps control exothermic reaction heat. Economic consideration are included. 3fs.

11808 Method for the production of methanation catalysts. Hammer, H.; Hakim, I. (to Bergwerksverband G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 2,519,580/A/. 18 Nov 1976. 9p. (In German).

A methanation catalyst is claimed which is produced by precipitation of nickel salts from alcoholic solutions. At the same time, these solutions contain aluminium or magnesium compounds and, in some cases, also a carrier medium. The precipitation agents are alkali boron hydride solutions and alkali carbonate solutions. The precipitate, which is preferably obtained at temperatures between -5 and +5°C, consists of a fine mixture of nickel boride, oxide hydrates, and hydroxides of nickel, magnesium, or aluminium. In contrast to the known nickel catalyst masses, it may be processed in air without inert gas. Four examples of preparations with suitable methanation tests are given.

11809 Substitute natural gas: routes and recent developments. Willis, R.H. *Gas Eng. Manage.;* **16**: No. 6, 211-219(Jun 1976).

A current status survey of gas production from solid and liquid fossil fuels covers basic principles of SNG production; process routes for SNG from coal; processes currently operational or ready for commercial operation (Lurgi, Koppers-Totzek, Winkler); processes under development and proposed (British Gas/Lurgi slagging gasifier, Hygas, CO_2 acceptor acceptor, BI-GAS, Synthane, and COGAS); SNG from oil shale; and SNG from biomass.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 11893, 11894, 11895, 11909, 12542

PROPERTIES

11810 Mixing effects in the ethanol—water system. Kessel'man, P.M.; Onufriev, I.V. (Odessa Inst. of Refrigeration Technology). *Russ. J. Phys. Chem. (Engl. Transl.);* **50**: No. 11, 1714-1717(Nov 1976).

Translated from Zh. Fiz. Kim.; 50: No. 11, 2883-2887(Nov 1976).

The heat of mixing, ΔH, and the volume of mixing, Δv, have been calculated for ethanol contents of 0-100% at temperatures 0-200°C and pressures up to 300 bars.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 11892, 11898

PROPERTIES

REFER ALSO TO CITATION(S) 11806

11811 Investigation of the diffusional collisions of molecules in binary mixtures with the aid of spin exchange. Zamaraev, K.I.; Kokorin, A.I. (Inst. of Chemical Physics, Moscow). *Russ. J. Phys. Chem. (Engl. Transl.);* **50**: No. 11, 1700-1702(Nov 1976).

Translated from Zh. Fiz. Kim.; 50: No. 11, 2855-2858(Nov 1976).

The kinetics of the decomposition of hydrogen peroxide on platinum adsorption catalysts and platinum black have been investigated using SiO_2, Al_2O_3, and aluminosilicate as carriers. The decomposition reaction has a fractional order (0.6) and is independent of the nature of the carrier. The catalysts are deactivated during the reaction, which leads to a discrepancy between the reaction order determined from the variation of the initial velocities with the initial concentrations and the value found in a single kinetic experiment. The apparent activation energy has been determined at 9-11 kcal $mole^{-1}$ for all the catalysts investigated.

11812 Molybdenum-catalysed oxidation of hydrazine by perchloric acid. Koltunov, V.S.; Tikhonov, M.F.; Kuperman, A.Ya. *Russ. J. Phys. Chem. (Engl. Transl.);* **50**: No. 11, 1702-1704(Nov 1976).

Translated from Zh. Fiz. Kim.; 50: No. 11, 2859-2862(Nov 1976).

The kinetics of the reaction between N_2H_4 and $HClO_4$ in an acid solution in the presence of molybdenum(VI) have been investigated. The reaction produces nitrogen and NH_4^+ and Cl^- ions. The reaction orders with respect to N_2H_4, $HClO_4$ and molybdenum are respectively 0, 1, and 0.5. The reaction mechanism is discussed. At a moderate concentration, perchloric acid is known not to oxidize hydrazine even at a high temperature, but preliminary experiments have shown, that in the presence of molybdenum salts (for example, ammonium molybdate) the reaction proceeds at an appreciable rate. Data on the stoichiometry and the kinetics of this catalytic reaction, which are lacking in the literature, are presented.

PREPARATION

REFER ALSO TO CITATION(S) 11431, 11432, 11457

11813 Method for the processing of synthesis gas. Gambrell, L.M. (to Allied Chemical Corp., Morristown, N.J. (USA)). German(FRG) Patent 2,604,164/A/. 26 Aug 1976. 16p. (In German).

The inventor intends to make it possible to convert the steam reformer plant from natural gas to fuel oil without having to exchange the gas burner. Besides, the invention has the aim to avoid the difficulties occurring in combustion of fuel oil (e.g. corrosion, slag formation, soot deposition). For this, 25-75% of the fuel oil should be vaporized at temperatures of 177-357°C in the presence of 5 - 90% steam (in relation to the weight of the vaporized fuel oil) and combusted subsequently in the burners. Further arrangements of the invention intend the superheating of the vaporized hydrocarbon fuel oil and the separation of the unvaporized fraction, which contains the impurities.

HYDRO ENERGY

RESOURCES AND AVAILABILITY

11814 Towards a policy framework for management of a muli-purpose reservoir system. Mohanty, R.P.; Patnaik, N. (University Coll. of Engineering, Orissa, India). *J. Inst. Eng. (India), Civ. Eng. Div.;* **57**: 293-298(May 1977).

Optimal management of multi-objective water resources systems is a complex problem with no exact extremum solutions, because some of the objectives may often be non-commensurate or may demand extra high priority due to national and regional interests. Parametric approach of optimizing a weighted function of objectives with several refinements of procedure is one of the accepted methods of analyzing such a problem. Such an approach is presented with a hierarchical ordering of one of the objectives which has been utilized for developing a set of possible operational alternatives from which the policy makers may have their choice of the operational figures. This work is concerned with an existing water resources system already operating with certain established goals and an attempt has been made to upgrade the goals and provide for future regional development. Linear programming has been used to obtain an implementable policy framework.

SITE GEOLOGY AND METEOROLOGY

REFER ALSO TO CITATION(S) 12498

11815 Flood forecasting at the Klaus power station of the Ennskraftwerke Ag. Moshammer, W.; Hamza, G. (Ennskraftwerke, Steyr, Austria). *Oesterr. Z. Elektrizitaetswirtsch.;* **30**: No. 6, 295-300(Jun 1977). (In German).

This Article describes a flood forecasting method and the installations used for this purpose. Based on the forecast, the headwater level can be drawn down to provide the necessary space for the retention of the flood peak. For the purpose of flood forecasting, three rainfall measurements representative of the catchment area and three stages of the main tributaries are transmitted to the power station. Using these values and making allowance for previous rainfall, the prevailing season, the rain storm duration and intensity, etc., a computer calculates the expected runoff as well as the amount of water to be discharged for an optimal water level drawdown. The result is typed out and transmitted, over a distance of 40 km, to the control center of the power station. The process computer is also used for the collection of information and operational data. This plant has been in operation since July 1975.

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 11841

11816 Excitation characteristics of Dehar hydro power plant generators. Thapar, O.D. (Univ. of Roorkee, India); Corcoran, J.C.W. *J. Inst. Eng. (India), Electr. Eng. Div.;* **57**: No. 6, 257-264(Jun 1977).

The 100 MW Dehar power plant is to be connected with the Northern Regional Grid of India by a single circuit 400 kV line and 220 kV lines in the first stage. 400 kV is to be introduced for the first time in the region. Stability of the 165 MW Dehar generators in the initial stage of development of 400 kV was achieved essentially by employing high gain fast acting static excitation system, and generators with normal characteristics were specified. Detailed studies were carried out to fix up the static excitation response, the required ceiling voltages and the type of a suitable feedback damping signal. The transient and dynamic stability studies carried out are described and discussed. Overvoltage withstand requirements of the excitation system are also discussed.

11817 Finite element analysis of power house substructures. Khalid, S. (Aligarh Muslim Univ., India); Rao, P.V. *J. Inst. Eng. (India), Civ. Eng. Div.;* **57**: 328-334(May 1977).

The geometry of a power house substructure is complicated because of the cavities due to draft tube, scroll case and inspection galleries. It is difficult to determine the stress distributions in mass concrete with such cavities and for the system of forces due to column and generator loads. The Finite Element method can be adopted to obtain stresses in substructures and intermediate structures of power houses. One such structure analyzed by the authors was represented by triangular elements interconnected at the nodes. Deformations at these points for all the elements satisfying the conditions of compatibility and equilibrium gave a series of simultaneous equations which were solved on an IBM 7044 computer. Sixty-four frames of substructure and twelve frames of intermediate structure with different proportions of draft tube and scroll case openings were thus analyzed. The results are presented in the form of tables and graphs.

11818 Excavation wall convergency: measurement experiences by an electro-optical diastimeter. Sampaolo, A.; Maggioni, G. (Ente Naz per l'Energ Elettr, Milan, Italy). *Energ. Elettr.;* **54**: No. 4, 201-208(Apr 1977). (In Italian).

During the excavation of underground power stations, there are to be taken into account the safety aspects and the economic implications due to the rock mass state of deformation. Among the various useful data to be collected, the wall convergency measurements is certainly one of the most significant for the above mentioned purposes. In order to gain such data at the Taloro underground hydraulic power station, a very precise electro-optical diastimeter has been used. The paper describes the peculiar features of the instrument and the operational usage during this first experience. The reported results and their evaluation demonstrate the reliability of the method and suggest for further applications of the electro-optical instrument in connection with underground excavation control.

11819 Excavation by milling machines of slants for the penstock seats of the upper Gesso power plants. *Energ. Elettr.;* **54**: No. 3, 149-153(Mar 1977). (In Italian).

After a short general description of the plant, the excavation method of inclined tunnels, into which penstocks are allocated, is discussed. The excavation is carried out in two stages as follows: 1st stage: excavation of reduced-section pilot heading, from the lower to the upper part; 2nd stage: downwards enlargement excavation to reach the final section. The excavation of pilot headings is then illustrated in detail; this has been carried out by means of two Wirth milling machines; some conclusions are drawn on their use.

11820 Device for converting the kinetic energy of an accelerated fluid into electrical energy. Schneider, D.J. German(FRG) Patent 2,529,534/A/. 27 Jan 1977. 23p. (In German).

The invention is concerned with a power engine which is to convert the kinetic energy of a flowing fluid into rotation energy. Initially, the flowing fluid activates blades which are fastened to two belts. These belts, in turn, are running over another pair of blades which start to rotate. Both rotational axes of the pairs of blades are arranged parallel above one another. The flowing fluid makes the front blades run in an upward movement, then it is diverted accordingly by means of wings, and the back blades run downwards.

11821 El Chocon and Planicie Banderita hydroelectric power stations in Argentina. Hoerl, G.; Rehm, H.J. (Siemens, Erlangen, Ger). *Siemens-Z.;* **49**: No. 7, 478-483(Jul 1975). (In German).

Argentina has recently been stepping up its efforts to exploit its water resources for generating electricity. Among the major projects is the El Chocon--Cerros Colorados scheme, for which Siemens is supplying eight large waterwheel generators with a total rating of 1650 MW. The generators represent a notable technical achievement both with respect to design and size.

ENVIRONMENTAL ASPECTS

11822 Statistical studies about the influence of the Lake Forggen upon the River Lech. Spiegel, R.P. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Hydraulik und Gewaesserkunde). *Wasser Boden;* **29**: No. 3, 73-75(Mar 1977). (In German).

As the comparison of the statistical parameters demonstrates, the Lake Forggen influences the flow of the river Lech very strongly in some respects. The Lech's water volume, very unstable mainly on account of the Alpine catchment area, is levelled up to a large extent. Some of the main problems concerning this reservoir are related with the optimum course of the banking period and the high-level water discharge, in particular during full capacity. For the determination of suitable discharge rules, these requirements, and other restrictions, too, have to be taken into account accordingly.

11823 Environmental balance in the construction of hydroelectric power plants. Papantscheff, C. *Oesterr. Z. Elektrizitaetswirtsch.;* **28**: No. 8, 413-426(Aug 1975). (In German).

The paper presents an attempt to quantify the value of national economic assets that are destroyed through the construction of a hydro-electric power plant, and to compare it with the investments associated with such construction but not directly belonging to it (e.g. sewerage and sewage treatment, roads, bridges etc). The balance is considered positive where the investments exceed the value of damage. Examples from Bulgaria illustrate these theoretical arguments.

POWER CONVERSION SYSTEMS

11824 Damage propagation due to faulty monitoring device in small hydroelectric generators. Kugler, H. (Tech Versicher, Munich, Ger). *Maschinenschaden;* **48**: No. 3, 77-80(1975). (In German).

By several examples of damages to small hydroelectric generators, it is illustrated which basic protective measures are necessary. Some additional possibilities of damage prevention are also outlined. 3 refs.

SOLAR ENERGY

REFER ALSO TO CITATION(S) 11940

11825 Solar energy: no brackets. Wettermark, G.; Stymne, H. (R Inst of Technol, Stockholm, Swed). *VVS - Tidskr. Varme, Vent., Sanit.;* **48**: No. 5, 49-64(May 1977). (In Swedish).

Potential utilization of solar energy in Sweden is discussed. Taking into account specific local climatic conditions, the problems involved in economical, large-scale, and long-term solar energy thermal storage and in the design of large solar power plants are examined. 7 refs.

11826 Solar engineering - activities in the field of new technologies. *Dornier-Post (Engl. Ed.);* No. 1, 5(1977). (In German).

A brief survey is presented of activities by the firm of Dornier System GmbH in the field of solar engineering. Fields of work are: Solar water and space heating, solar sea water desalination, solar cooling, solar electricity generation, solar pump, solar air-conditioning.

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 11940, 12662

11827 Investigation of atmospheric radiation. Its recording with the aid of a classification method. Frank, W.; Holz, D.; Snatzke, C. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Holzkirchen (Germany, F.R.). Inst. fuer Bauphysik). *Gesund.-Ing.;* **97**: No. 9, 193-200(Sep 1976). (In German).

A measuring device is described with the aid of which the duration of certain intensity interval occurrences during solar radiation (e.g. with interval ranges of 100 kcal/m²h each) can be determined in a simple way (classification device). With five such installations, radiation received on variously orientated colletor areas was recorded and evaluated over the course of one year in the open-air test area of Holzkirchen (horizonal surface and vertical surfaces

orientated according to the four main cardinal points). The results presented in tabular form and in graphs are discussed. They enable more extensive statements to be made on radiation conditions as mean and maximum values of radiation.

11828 Estimation of the total solar radiation from meteorological data. Sabbagh, J.A.; Sayigh, A.A.M.; El-Salam, E.M.A. (Univ. of Riyadh, Saudia Arabia). *Sol. Energy;* **19**: No. 3, 307-310(Oct 1977).

The formula proposed can be used to estimate the solar radiation intensity fairly accurately in areas lacking such data. It relates the solar radiation intensity to the well established climatological data, i.e., sunshine duration, relative humidity and maximum temperature. Also to the geographical parameters, i.e., altitude, latitude of the location. The formula can be applied accurately to different locations with the same average best fitted coefficient. This makes the formula ready to be applied even in areas where there is no data available. Yearly and monthly total solar radiation were estimated within an average error of +- 5 percent. Using the appropriate K and the coefficient of 1.53, the formula Q = 1.53 K exp L(D - R/sup $^1/_3$//100-1/t) can be used to predict total solar radiation on flat surface at any location. However it should be noted that the accuracy of this formula was tested in arid and semi-arid zones only.

ECONOMICS

REFER ALSO TO CITATION(S) 11829, 11918

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 11918

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 11914

11829 (COO/4094—2) **Economics of adopting solar photovoltaic energy systems in irrigation.** Matlin, R.W.; Katzman, M.T. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 11 Jul 1977. Contract EY-76-C-02-4094. 53p. Dep. NTIS, PC A04/MF A01.

An economic analysis concerning the adoption of solar photovoltaic energy systems in irrigation has been made compared to conventional fossil fuel energy sources. The basis for this analysis is presented along with a discussion as to the time of initial profitability, the time of optimal investment, the effects of the tax system, the cost per acre that would make irrigation unviable, and possible governmental incentives that would promote the deployment of photovoltaic irrigation systems between the time of initial profitability and the time of optimal investment.

11830 (DSE/2460—2) **Improved semiconductors for photovoltaic solar cells. Quarterly report No. 2, October 1, 1976—December 31, 1976.** Brindle, D.; Catalano, A.W.; Cambridge, J.; Dalal, V.; Dalton, V.; Fagen, E.A.; Gribbin, F.; Hall, R.B.; Meakin, J.D.; Warfield, G. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Oct 1977. Contract EX-76-C-01-2460. 53p. Dep. NTIS, PC A04/MF A01.

Zn_3P_2 is now being synthesized routinely from pure zinc and phosphorous. Work has continued on the preparation of thin films by physical vapor deposition using only IEC synthesized starting material. The influence of growth parameters such as growth rate, source and substrate temperatures on film structure, resistivity and optical absorption were investigated. No significant correlation of structural, electrical or optical properties of the films was found with growth rate over the range 0.3 to 2.0 $\mu g/cm^2$-sec.

11831 (ERDA/JPL/954334—77/3) **Establishment of the feasibility of a process capable of low cost, high volume production of silane (Phase I), and the pyrolysis of silane to semiconductor-grade silicon (Phase II). Low Cost Silicon Solar Array Project, Task I. Quarterly progress report, April—June 1977.** Breneman, W.C.; Farrier, E.G.; Mui, J.Y.P.; Rexer, J. (Union Carbide Corp., Sistersville, W.Va. (USA); Union Carbide Corp., Parma, Ohio (USA). Carbon Products Div.). Oct 1977. Contract NAS-7-100-954334. 49p. Dep. NTIS, PC A03/MF A01.

The purpose of this program is to establish the practicality of a process for the high volume, low cost production of silane and its subsequent pyrolysis into a semi-conductive grade silicon metal. A small process develop unit for producing silane from dichlorosilane (DCS) using a tertiary amine functional ion exchange resin as a catalyst for a redistribution reaction has been operated successfully on what is now a routine basis. High quality silane has been produced in good yield and limiting equipment size has been identified. The silane gas product is essentially free of foreign compounds (to 5 ppM detection limit) and produces a silicon epitaxial film with a resistivity of 20 ohm cm and very strong "N" type character. Epi film quality was very good. The overall yield of silane was 92% of theory. The production rate, limited by the 2.66 cm diameter distillation column, was 112 g/hr. Design of a silicon tetrachloride (STC) hydrogenation reactor used to convert co-product STC to trichlorosilane has been completed and fabrication and installation are underway, as is a modification of the silane unit to permit use of trichlorosilane as feed, producing STC and silane. The production of silicon by the pyrolysis of silane is currently being accomplished in a free space reactor. The free space reactor product is a very fine powder which is then consolidated by melting. The melt is cast into rods. Analysis of the product from earlier experiments indicated that metal or graphite liners in the reaction chamber region resulted in product contamination. A quartz liner is currently being evaluated in the reaction chamber. Other identified contamination sources are air borne particles and contamination during melting and/or casting.

11832 (ERDA/JPL/954339—77/7) **Evaluation of selected chemical processes for production of low-cost silicon, (Phase II). Seventh quarterly progress report, April 1, 1977—June 30, 1977.** Blocher, J.M. Jr.; Browning, M.F.; Wilson, W.J.; Carmichael, D.C. (Battelle Columbus Labs., Ohio (USA)). 20 Jun 1977. Contract NAS-7-100-954339. 32p. Dep. NTIS, PC A03/MF A01.

During Phase I of this program (concluded in October of 1976), economic analyses and experimental work were carried out on the fluidized-bed zinc reduction of $SiCl_4$ and on several modifications of the iodide process (SiI_4 decomposition or reduction) which led to the selection of the fluidized-bed zinc reduction of $SiCl_4$ as a promising candidate for supplying low-cost solar- or semiconductor-grade silicon. Phase II of the program, which is described, has as its objective, designing an experimental facility (tentative 25 MT Si/year capacity) and carrying out an experimental program to support the design effort. Updates of plant and production cost estimates at the 1000 MT/year level are to be made based on the design experience.

11833 (ERDA/JPL/954343—77/3) **Process feasibility study in support of Silicon Material Task I. Quarterly technical progress report (VIII).** Fang, C.S.; Hansen, K.C.; Miller, J.W. Jr.; Yaws, C.L. (Lamar Univ., Beaumont, Tex. (USA). Dept. of Chemical Engineering). Sep 1977. Contract NAS-7-100-954343. 68p. Dep. NTIS, PC A04/MF A01.

Major activities during this reporting period were focused on process system properties, chemical engineering and economic analyses. Analyses of process system properties were continued for silicon course materials under consideration for solar cell grade silicon including data collection, analysis, estimation and correlation. Initial correlation efforts focused on vapor pressure data which are extremely important in phase equilibria in a chemical plant processing silicon source materials. The vapor pressure of silicon tetrachloride as a function of temperature was correlated by the relation log P/sub v/ = A + B/T + C log T + DT + ET^2. Values for the correlation constants A,B,C,D and E are presented. Correlation results for gas phase heat capacity of silicon tetrachloride C/sub p/ + A + BT + CT^2 + DT^3 are presented including data from American, Russian, German and Japanese sources. The apparatus for measuring thermal conductivity of gases was assembled and calibrated. Chemical engineering analysis was continued on the silane process (Union Carbide). The review and modification of the preliminary process design for the conventional polysilicon process were completed, and results are presented. Cost analysis activities for the production of semiconductor grade polysilicon via the conventional hair pin process technology were continued. Results are presented.

11834 (ERDA/JPL/954363—77/1) **Phase I of the automated array assembly task of the low cost silicon solar array project. Annual technical report. Motorola report No. 2258/4.** Coleman, M.G.; Pryor, R.A.; Grenon, L.A.; Lesk, I.A. (Motorola, Inc., Phoenix, Ariz. (USA). Semiconductor Group). Feb 1977. Contract NAS-7-100-954363. 115p. Dep. NTIS, PC A06/MF A01.

Work performed to analyze, both technically and economically, the state of technology readiness for the automated production of solar cells and modules is compiled and reviewed critically. The long-term objective solar module characteristics include a selling price of less than $.50/peak watt and a mean-time-before-failure (MTBF) of 20 years in any terrestrial environment. While efficiency is important to attaining the cost goal, it is a most significant factor in array economics; accordingly, this program has stressed high efficiency, with a suggested cell goal of 15 percent. The analysis emphasized technical evaluation of individual process steps first, and then concentrated upon process sequences for making solar cells and modules. Further analysis was performed to yield a detailed cost study of individual process steps; this was applied to the cost analysis of potential process sequences. Potentially economical process se-

quences formed from process steps deemed to have high technical merit were then identified. Potentially promising technologies needing further development to achieve satisfactory maturity were then identified. It is concluded that, while specific areas of technology need advanced development and the source of silicon needs definition, no fundamentally new technology needs to be developed to permit manufacture of solar cells which will meet the 1985 LSSA Program cost goals.

11835 (ERDA/JPL/954374—77/2) **Slicing of silicon into sheet material. Silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Fifth quarterly report, March 21, 1977—May 27, 1977.** Holden, S.C.; Fleming, J.R. (Varian Associates, Lexington, Mass. (USA). Lexington Vacuum Div.). 7 Jul 1977. Contract NAS-7-100-954374. 73p. Dep. NTIS, PC A04/MF A01.

The multiblade slurry technique capable of slicing 10 cm ingot into wafers 0.25 mm thick with only 0.20 mm kerf loss and 98% yield has been demonstrated. The total silicon requirement represents an ingot to sheet conversion of 0.95 m^2/kg. Full production slicing tests have demonstrated the cost of MS slicing to contribute \$40 to \$50/m^2, with "best effort" estimates for today's configuration to be \$30 to \$35/m^2. By reducing material cost, and increasing the specific capacity of a saw to slice 900 wafers simultaneously, the long-term cost of MS slicing is estimated to be less than \$10/m^2. The conversion of ingot to sheet is shown to be the most valuable contribution of slicing technology. At today's ingot costs, and with the thin wafer, low kerf loss slicing techniques demonstrated, the silicon material represents 5 to 10 times the cost of the wafering process in finished silicon wafers. Increasing the number of blades used in MS slicing from 100 to 150 to 225 to 300 has resulted in a reduction of yield to 33 to 70% for thin slicing, or an increase in wafer thickness to 0.30 mm slices. The limitation is intrinsic misalignment of multiple blades. A technique to correct this condition is presented and forms a key element in low cost slicing. Analysis of blade material accuracy shows that straightness and flatness specifications can be relaxed. The success of the blade alignment technique will allow lower thickness accuracy requirements. The goal is to use blade materials 50% as costly as used presently, reducing the cost of this expendible material.

11836 (ERDA/JPL/954458—77/3) **Accelerated/abbreviated test methods, study 4 of task 3 (encapsulation) of the Low-Cost Silicon Solar Array Project. Fifth quarterly progress report, April—June 1977.** Kolyer, J.M. (Rockwell International Corp., Anaheim, Calif. (USA). Autonetics Group). 1 Jul 1977. Contract NAS-7-100-954458. 30p. Dep. NTIS, PC A03/MF A01.

Methodology for evaluating the inherent weatherability of the transparent encapsulant component of a solar cell array system was determined. Inherent weatherability is controlled by the three basic weather factors common to all outdoor exposures: insolation, temperature, and humidity. Plastic films and encapsulated solar cells were exposed to both natural and accelerated conditions. Failure modes and the effect of weather factors on degradation rates were disclosed. Quantitative data allowed trial of mathematical models, and graphical predictions were made for changes in a number of properties on outdoor exposure. These predictions are presented here. Results are presented for the outdoor weather program, moisture-related deterioration of solar cell contacts, transmittance at 360 nm, breaking stress for polystyrene, tensile properties for Lexan, loss of gloss for Lexan, and accelerated exposure testing. Nine different encapsulant systems for testing are listed. (MHR)

11837 (ERDA/JPL/954506—77/3) **Hot forming of silicon sheet, silicon sheet growth development for the large area silicon sheet task of the Low Cost Silicon Solar Array Project. Quarterly report No. 5, March 31, 1977—June 30, 1977.** Graham, C.D. Jr.; Gholamnezhad, A.H.; Lall, C.; Pope, D.P.; Strauss, P.; Wolf, M. (Pennsylvania Univ., Philadelphia (USA)). 26 Jul 1977. Contract NAS-7-100-954506. 14p. Dep. NTIS, PC A02/MF A01.

Progress on a program to determine the conditions under which sheets of silicon might be produced by a rolling process is described. Samples of p-type polycrystalline silicon produced by chemical vapor deposition and supplied by the Dow Corning Corp. are being deformed at strain rates of 5 sec^{-1} to strains of between 36% and 56% and are subsequently being recrystallized. Samples are then being submitted to JPL for electrical evaluation. To date, some preliminary experiments to test the effect of the environment in the deformation and annealing apparatus have been performed and these samples have been submitted to JPL for evaluation. Four samples have been deformed at a strain rate of 5 sec^{-1} and are now in the process of being annealed prior to submission to JPL for evaluation.

11838 (ERDA/JPL/954560—77/4) **Synthesis of silane and silicon in a non-equilibrium plasma jet. Fourth quarterly report, March 21—June 20, 1977.** Calcote, H.F.; Felder, W. (Aerochem Research Labs., Inc., Princeton, N.J. (USA)). Jul 1977. Contract NAS-7-100-954560. 35p. (AeroChem-TN—176). Dep. NTIS, PC A03/MF A01.

The feasibility of high volume, low cost production of high purity silane or solar grade silicon using a non-equilibrium hydrogen atom plasma jet was determined. Reactions of hydrogen atoms in the plasma jet with chlorosilanes (added either to the discharge or to the hydrogen atom stream) are being studied. Products of the H/$SiCl_4$ reaction were collected and quantitatively analyzed using a fractionation/distillation-mass spectrometric technique. Conversion of $SiCl_4$ to lower chlorosilanes and solid (Si) was on the order of 10 percent. The percentage conversion was found to depend upon equivalence ratio (ratio of $SiCl_4$ to H concentrations) and reaction zone pressure. Electronic grade reagent $SiCl_4$ gave smaller product yield and different product distribution than did technical grade. Real-time, in situ mass spectrometric sampling of the H/H_2/$SiCl_4$ reaction zone gases was initiated. Quantitative results have not been obtained due to the complexity of the chlorosilane mass spectra, and consequent resolution and sensitivity difficulties with the mass spectrometer. Improvements in the instrumentation needed for these measurements are discussed. The performance of the flower petal nozzle, No. 5 was characterized. Current/voltage behavior was similar to that previously observed in the nozzle-as-anode mode of operation for simpler nozzles. Hydrogen atom yields of approximately 1 percent are obtainable with production efficiencies of approximately 2 to 3 moles H/kWh of discharge energy. A remeasurement of yields and production efficiencies from the simpler nozzle No. 2 confirmed yields of approximately 3 percent for H atoms and production efficiencies of approximately 5 moles H/kWh. Measurements of H-atom yields were found to depend upon reagent mixing conditions, indicating the need to continue investigations of the mixing properties.

11839 (ERDA/JPL/954607—77/1) **Development and testing of shingle-type solar cell modules. Quarterly report No. 1.** Shepard, N.F. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 5 Oct 1977. Contract NAS-7-100-954607. 57p. Dep. NTIS, PC A04/MF A01.

The initial task efforts to develop a shingle-type solar cell module, which is suitable for use in place of shingles on the sloping roof of residential or commercial buildings, are reported. Several promising shingle module design concepts are presented. Based on these concepts, development efforts are proceeding on bonding of solar cells to glass with polyvinyl butyral film, laminating the multilayer shingle substrate, and embedding solar cells within a methyl methacrylate casting. Testing of various fastener approaches for the interconnection of adjacent modules on the roof has been started. The configuration of each of these interconnector concepts is discussed.

11840 (ERDA/JPL/954654—77/1) **Silicon web process development. First quarterly report, April 20, 1977—June 30, 1977.** Duncan, C.S.; Seidensticker, R.G.; McHugh, J.P.; Blais, P.D.; Davis, J.R. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Research and Development Center). Aug 1977. Contract NAS-7-100-954654. 82p. Dep. NTIS, PC A05/MF A01.

Seventeen (17) experimental web growth furnace runs were carried out during this period, of which 15 yielded 4 to 10 webs each. Web lengths of nearly two meters and widths up to 22 mm were achieved. A variety of lid and susceptor configurations have been used to modify the thermal geometry of the melt in an effort to grow wider web crystals. Currently, the dendritic web crystals which have been grown have been characterized mainly on the basis of physical dimensions. It appears that the specific widening rate of the crystals, length per unit time, is relatively independent of susceptor geometry or web dimension. Some four probe resistivity measurements have been made to validate the melt doping procedure, and preliminary work is being done with regard to developing a "standard" solar cell design and processing procedure for future device studies on dendritic web. A circular susceptor/crucible geometry is currently being modeled using a finite element analysis code. The model is essentially complete and will be run in the near future. In addition, an analysis is being done on the dissipation of latent heat from the growth front by both the crystal itself and to the supercooled melt. The model for the heat loss from the web is essentially complete. Design of a new web growth facility of greater dimensional capacity is progressing without difficulty. Refinement modifications of the existing web growth facility have been completed.

11841 **Solar electric power generation: citations from the Engineering Index data base.** Hundemann, A.S. (Ed.). Springfield, VA; National Technical Information Service (1970). 190p.

A worldwide literature survey cites power generation by direct conversion with solar cells and indirect conversion using solar heat. Topic areas cover solar tower power plants, orbital solar energy technology, photovoltaic power generation, and solar augmentation of hydroelectric power systems. A few abstracts pertain to the future role that solar energy will play in production of electric power and general studies comparing the technical and economic feasibility of various methods of electric power generation. Abstracts dealing with solar sea power generation and spacecraft power sup-

plies are excluded. This bibliography was prepared by searching the 1970-September 1976 data base of Engineering Index. It contains 190 abstracts.

11842 (SAND—77-0814) **PVSS: a photovoltaic system simulation program users manual.** Goldstein, L.H.; Case, G.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1977. Contract EY-76-C-04-0789. 46p. MF A01.

The PVSS code has been developed to accurately simulate the performance of a photovoltaic system. Sixteen system configurations can be modeled using such components as batteries, inverters, dc-voltage regulators, and maximum power point trackers. When the user supplies data describing incident light intensity and load demand, the PVSS program computes the power available at the output terminals of each system component, the energy surplus produced or deficit incurred by the system as a whole, and the battery state of charge for systems possessing battery storage. Procedures for defining a photovoltaic system and specifying a simulation are discussed. The theory used in developing simulation models is explained to the extent necessary to understand the accuracy of the models used. Finally, several sample runs are discussed to illustrate the behavior of the program in simulating various photovoltaic systems.

11843 **High voltage, high current Schottky barrier solar cell.** Fletcher, J.C.; Stirn, R.J. US Patent 4,053,918. 11 Oct 1977. Filed date 5 Aug 1974. 6p.

A Schottky barrier solar cell is disclosed, consisting of a layer of wide band gap semiconductor material such as AlGaAs on which a very thin film of semi-transparent metal is deposited to form a Schottky barrier. The layer of the wide band gap semiconductor material is on top of a layer of narrower band gap semiconductor material, to which one of the cell's contacts may be attached directly or through a substrate. The cell's other contact is a grid structure which is deposited on the thin metal film.

11844 **Cost studies on terrestrial photovoltaic power system with sunlight concentration.** Evans, D.L.; Florschuetz, L.W. (Arizona State Univ., Tempe). *Sol. Energy;* **19**: No. 3, 255-262(Oct 1977).

A systems simulation program for comparing the energy costs associated with various alternative concentrating photovoltaic solar systems to energy costs expected with flat arrays is described. The application to linear focus and point focus concentrators is presented in a parameterized way. The results show that concentration offers a distinct cost advantage at high cell costs. However, they also show that concentration has the potential for being a viable alternative to the flat unconcentrated arrays for cell costs as low as $50/m^2. Also, for a given concentrator cost, cell cost and cell cooling effectiveness, there exists an optimum effective aperture area to cell area ratio. For reasonable projected cell costs, this optimum ratio is below 30 for passively cooled devices and below 60 for actively cooled systems.

11845 **Comparison of GaAs and Si hybrid solar power systems.** Heinbockel, J.H. (Old Dominion Univ., Norfolk, VA); Roberts, A.S. Jr. *Sol. Energy;* **19**: No. 3, 291-300(Oct 1977).

Various silicon hybrid systems are modeled and compared with a gallium arsenide hybrid system. The hybrid systems modeled produce electric power and also thermal power which can be used for heating or air conditioning. Various performance indices are defined and are used to compare the system performance. The performance indices are: capital cost per unit electric power out; capital cost per total power out; capital cost per unit electric power plus mechanical power; annual cost per unit electric energy; and annual cost per unit electric plus mechanical work. These performance indices indicate that concentrator hybrid systems can be cost effective when compared with present day energy costs. Realistic costs and efficiencies of GaAs and Si are respectively $35,000/m^2 for 15 percent efficient solar cells and $1000/m^2 for 10 percent efficient solar cells based on information available at the time of this study in late 1975. The performance indices show that the limiting values for annual costs are 10.3 cents/kWh and 6.8 cents/kWh for Si and GaAs, respectively. Results demonstrate that for a given flow rate there is an optimal operating condition for maximum photovoltaic output associated with concentrator systems. Also concentrator hybrid systems produce a distinct cost advantage over flat hybrid systems. 35 references.

11846 **Simple laboratory procedure for making silicon solar cells without specialist equipment.** Daruvala, D.J. (Middlesex Polytechnic, Eng.). *Sol. Energy;* **19**: No. 3, 313-314(Oct 1977).

An experimental procedure suitable for students for making silicon solar cells is described step by step. How the technique was developed is explained briefly. (MHR)

11847 **Various configurations for continuous silicon solar cells.** Sameh, M. (Cairo Univ., Egypt). *Sol. Energy;* **19**: No. 3, 315-316(Oct 1977).

For the same exposed silicon area, solar cells may be produced in a more convenient and mechanically rugged structure than narrow thin ribbons or sheets. Compactness ratio is calculated for each of several suggested geometries. For an Archimedes and square spirals, compactness ratio increases with increasing number of turns and closer tolerance. For a serpent, compactness ratio increases with decreasing number of turns, closer tolerance and increasing ratio of ribbon width to side length. For a zigzag compactness ratio is minimum for an apex angle 45° and smaller ratio of ribbon width to side length.

11848 **Solar cell package.** Coleman, M.G.; Pryor, R.A. (to Motorola, Inc.). US Patent 4,045,245. 30 Aug 1977. Filed date 5 Jan 1976. 8p.

A solar cell package includes a plurality of solar cells within a space formed by a support member and a transparent cover member. A first conductor is positioned between the support member and the solar cells and makes electrical contact to a first surface of each of the solar cells. A second conductor is essentially coplanar with the first conductor and makes electrical contacts to a second surface of each of the solar cells. The output terminals of the solar cell package are connected to the first and second conductors. The first and second conductors are electrically isolated from each other and are also insulated from the support member and from the solar cells insulative means which is electrically insulated but thermally conductive to facilitate dissipation of thermal power dissipated in the solar cells.

11849 **Solar conversion efficiency of pressure sintered cadmium selenide liquid junction cells.** Miller, B.; Robbins, M.; Menezes, S.; Chang, K.C.; Thomson, J. Jr.; Heller, A. (Bell Labs, Murray Hill, NJ). *J. Electrochem. Soc.;* **124**: No. 7, 1019-1020(Jul 1977).

Pressure sintered electrodes of cadmium selenide subsequently doped with cadmium vapor have shown solar energy conversion efficiencies approaching 3/4 of those of single crystal specimens in sunlight experiments. The cell CdSe/1F Na_2S-1F S-1F NaOH/C has operated at 5.1% conversion efficiency under AM2 conditions with polycrystalline electrodes. The relatively small sacrifice of efficiency from single crystal values of 7.5 plus or minus 0.5% suggests the possibility of substantial cost advantage. The temperature and pressure conditions, cadmium doping procedure, material characterization, and the voltammetric behavior of the cell are discussed.

11850 **Meteorological effects on solar cells.** Mallinson, J.R.; Landsberg, P.T. (Univ of Southampton, Engl). *Proc. R. Soc. (London), Ser. A;* **355**: No. 1680, 115-130(30 Jun 1977).

A basic device for the direct conversion of solar radiation into electricity is the solar cell, and considerable effort throughout the world is being directed towards the development of low-cost cells for terrestrial use. The effect of different meteorological conditions on solar cell outputs has been investigated, using a model for a solar cell ((p-on-n or n-on-p) which incorporates surface recombination, surface region electric field and series resistance. The attention is concentrated on the physical principles, with special reference to certain meteorological aspects. 28 refs.

11851 **Polycrystalline indium phosphide solar cells fabricated on molybdenum substrates.** Saitoh, T.; Matsubara, S.; Minagawa, S. (Hitachi Ltd, Tokyo, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. 5, 807-812(May 1977).

Heterojunctions on polycrystalline indium phosphide films are fabricated and characterized. The InP films are chemically deposited on molybdenum substrates. Cuprous selenide films, being cubic in crystal structre and degenerate in conduction, are prepared on n-type InP films. Cu$sub x$Se/InP thin film solar cells have efficiencies of up to 1.7% with a short circuit current density of 11 mA/cm$sup 2$ under AM 1 simulated irradiation. Furthermore, CdS/InP heterojunction solar cells are fabricated by evaporating indium-doped CdS films on zinc-doped InP surfaces. The efficiency directly increases with the annealing temperature of the cells up to 2.0% with a short-circuit current density of 18 mA/cm$sup 2$. A collection efficiency of 70% is obtained at a wavelength of 0.65 mum from a spectral response curve. 17 refs.

11852 **Solar cell mounting and interconnecting assembly.** Kurth, W.T. (to Mobil Tyco Solar Energy Corp.). US Patent 4,019,924. 26 Apr 1977. Filed date 14 Nov 1975. 10p.

A solar cell assembly comprises a plurality of solar cells mounted on a laminate comprising a base electrically-insulative sheet, an electrically-conductive layer disposed on the base sheet in a predetermined pattern so as to provide first and second cell-connecting sections electrically insulated from one another, and a second electrically-insulative sheet having a plurality of openings and being disposed over the conductive layer so that selected portions of the conductive layer are exposed through the openings. The laminate is provided with a plurality of bent tabs, each of which includes an exposed portion of the first cell-connecting section so that the exposed portion can be attached to the top surface electrode of a solar cell. At least one exposed portion of a second cell-connecting section of the conductive layer is attached to the bottom surface electrode of the same cell. Various circuit patterns of the electrical-

ly-conductive layer are described for connecting the cells in a series or parallel array and for use in width-limited systems, such as solar concentrators.

11853 Theory of transient photovoltaic effects used for measurement of lifetime of carriers in solar cells. Dhariwal, S.R.; Kothari, L.S.; Jain, S.C. (Gov Coll, Ajmer, India). *Solid-State Electron.;* **20**: No. 4, 297-304(Apr 1977).

Transient photovoltaic effects are frequently used for measurement of lifetime of the carriers in solar cells. A detailed theoretical analysis of transient photocurrent, photovoltage and photoconductivity of a solar cell is presented, considering the actual absorption coefficient of light and a finite surface recombination velocity. Application of the theory to the measurement of lifetime of the carriers is discussed. Decay time of photocurrent for a very thin cell comes out to be independent of the lifetime of the carriers but is found to depend on its thickness. This is in agreement with the experimental observation of earlier workers. 3 refs.

11854 Cds/Cu_2s solar cell. I. Minority carrier generation and transport in the Cu_2s emitter. Boeer, K.W. (Univ of Del, Newark). *Phys. Status Solidi (a);* **40**: No. 2, 355-384(Apr 1977).

It is the purpose of this review to summarize the theory of the photovoltaic effect in the CdS/Cu_2S heterojunction, and to present some of the numerical results not previously published. According to the different phenomena involved this review paper is divided into a first part dealing with minority carrier generation, recombination, and diffusion in Cu_2S, and a second part dealing with space charge and high-field effects in the junction, presented here deals with a simplified planar sandwich with one relevant coordinate (x)--except for optical properties at the rough Cu_2S surface. Some preliminary remarks about the influence of surface roughness on the electrical properties of the actual cell are added. 28 refs.

11855 Fundamental electronic mechanisms limiting the performance of solar cells. Lindholm, F.A.; Sah, C. (Univ of Fla, Gainesville). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 299-304(Apr 1977).

The efficiency of a solar cell depends on the electronic parameters which characterize the transport, recombination, and generation of electrons and holes in semiconductors. This paper describes the many basic mechanisms that can control these electronic parameters in solar cell materials. 25 refs.

11856 Performance limitations of silicon solar cells. Huaser, J.R. (NC State Univ, Raleigh). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 305-321(Apr 1977).

This paper discusses the performance limitations of silicon solar cells which have been identified and investigated using a detailed numerical analysis of solar cell operation. Efficiency limitations are discussed as related to doping densities, minority carrier lifetimes, widths of solar cell regions, surface recombinaton, antireflecting layers, and ohmic contact stripes. Areas in which improvements can be expected in performance are identified and discussed. 33 refs.

11857 Physical operation of back-surface-field silicon solar cells. Fossum, J.G. (Sandia Lab, Albuquerque, NM). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 322-325(Apr 1977).

Using exact numerical solutions of carrier transport in the back-surface-field silicon solar cell both for guidance and for verification, the physical mechanisms effective in this device are identified and explained. Concise analytical descriptions of the cell performance, based on the pertinent device physics, are formulated.

11858 Dependence of open-circuit voltage on illumination level in p-n juncton solar cells. Fossum, J.G.; Lindholm, F.A. (Sandia Lab, Albuquerque, NM). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 325-329(Apr 1977).

Simple analytical dependencies of solar cell open-circuit voltage on illumination level, valid for high injection, are derived. The developments are guided and verified by exact computer-aided numerical simulations of silicon cells. The results are related to an easily measured device parameter, the uncompensated photocurrent, through the use of the principle of superposition. An advantage of p^+-n over n^+-p cells with respect to open-circuit voltage at high levels of illumination is predicted. 7 refs.

11859 Optimization of silicon solar cell design for use under concentrated sunlight. Crook, D.L.; Yeargan, J.R. (Univ of Ark, Fayetteville). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 330-336(Apr 1977).

The computations are in terms of nine design parameters and include losses from recombination, series resistance, contact coverage, and reflection. Each of these parameters have an adverse effect on collection efficiency and series resistance resulting in some optimum value between the two extreme limits of each parameter. The collection efficiency should be maximized when operating under low intensities because the loss due to the series resistance will be small. However, the series resistance should be minimized when operating under high intensities because the loss due to series resistance is the major loss. Therefore, the optimum design depends upon the intensity at which the solar cell is to be operated. 11 refs.

11860 First order theory of the p^+-n-n^+ edge-illuminated silicon solar cell at very high injection levels. Goradia, C.; Sater, B.L. (Cleveland State Univ, Ohio). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 342-351(Apr 1977).

A first order theory of the edge-illuminated p^+-n-n^+ silicon solar cell under very high injection levels has been derived. The very high injection level illuminated J-V characteristic is derived for any general base width to diffusion length (W/L) ratio and it includes the minority carrier reflection by the n-n^+ high-low junction. The beneficial effects of the high-low junction are shown to be significant until extremely high injection levels are reached. The theoretical dependencies of J/sub sc/ and V/sub oc/ on temperature, incident intensity, and base resistivity are derived and discussed in detail. Some experimental results are given and these are discussed in relation to the theory. 20 refs.

11861 Carrier generation, recombination, trapping, and transport in semiconductors with position-dependent composition. Sah, C.; Lindholm, F.A. (Univ of Ill, Urbana). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 358-362(Apr 1977).

The spatial variation of the chemical composition of a semiconductor modifies the ideal one-electron energy band model as well as the Shockley equations for carrier recombination and transport in two important ways. The random component of the spatial variation introduces localized states in the energy gap by perturbing the band states. The nonrandom component gives rise to the position dependences of the conduction and valence band edges of the electron affinity and the energy gap. This paper gives the modifications of the Shockley equations from these two effects as well as an example of the steady-state recombination rate from distributed gap states in junction solar cells. 16 refs.

11862 Computer analysis of heterojunction and graded composition solar cells. Sutherland, J.E.; Hauser, J.R. (NC State Univ, Raleigh). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 363-372(Apr 1977).

The development and application of a variable composition solar cell computer analysis program is discussed. The basic device equations as used in the computer analysis are derived and the techniques used to model material parameter variatons described. Finally, the results of the computer analysis of several Al/sub x/Ga/sub 1-x/As and GaAs/sub 1-x/P/sub x/ solar cell structures are presented along with a discussion of the effects of interface states and various composition and doping profiles on maximum solar cell efficiency. 21 refs.

11863 Design analysis of the thin-film CdS—Cu_2S solar cell. Rothwarf, A.; Barnett, A.M. (Univ of Del, Newark). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 381-387(Apr 1977).

A detailed model of the CdS--Cu_2S solar cell was used to analyze design limits of cell configurations based on present laboratory technology. The parameters controlling the short-circuit current, open-circuit voltage, and fill factor are treated. The limits for each of these factors is obtained. The results indicate that the attainable conversion efficiency of the CdS--Cu_2S solar cell extrapolating from the present processing technology is roughly 10 percent, as compared to a theoretical efficiency of 16 percent, if no losses occurred. A similar analysis for a cell using Cd/sub 1-x/Zn/sub x/S in place of CdS yields an attainable efficiency of 15 percent and a theoretical efficiency of over 26 percent. 22 refs.

11864 Collection efficiency of heterojunction solar cells. De Vos, A.; Pauwels, H.J. (Lab voor Elektron en Meetechniek, Ghent, Belg). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 388-392(Apr 1977).

The dependence of the generation efficiency k, the collection efficiency Q, and the current efficiency sigma = kQ of a heterojunction solar cell on the two semiconductor bandgaps E/sub g1/ and E/sub g2/ is investigated. It is assumed that the two semiconductors have ideal absorption characteristics. It is shown that a heterojunction solar cell can exhibit a better current efficiency sigma than a homojunction solar cell, if the semiconductor with the larger bandgap is situated at the illuminated side of the junction. 4 refs.

11865 Methodology for experimentally based determinaton of gap shrinkage and effective lifetimes in the emitter and base of p-n junction solar cells and other p-n junction devices. Lindholm, F.A.; Neugroschel, A.; Sah, C.; Godlewiski, M.P.; Brandhorst, H.W. Jr. (Univ of Fla, Gainesville). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 402-410(Apr 1977).

The methodology pertains to a solar cell after the junction is formed. Hence each material parameter determined includes the effects of the processing used in junction fabrication. The methodology consists of strategy and procedures for designed experiments and interpreting data consistently with the physical mechanisms governing device behavior. This careful linking to the device phys-

ics uncovers the material parameters concelaed in the data. To illustrate the procedures, they are applied to an n^+-p solar cell having substrate resistivity of about 0.1 Ω*cm. 21 refs.

11866 Detection of recombination centers in solar cells from junction capacitance transients. Sah, C. (Univ of Ill, Urbana). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 410-419(Apr 1977).

The relations between the parameters which characterize electron-hole generation-recombination-trapping (GRT) centers and the electrical characteristics and efficiency of solar cells are discussed. The physics and the procedures of using the transient capacitance techniques to measure these GRT parameters in p-n junction, Schottky and MOS solar cells are presented with many experimental examples. 16 refs.

11867 Investigation of the double exponential in the current—voltage characteristics of silicon solar cells. Wolf, M.; Noel, G.T.; Stirn, R.J. (Univ of Pa, Philadelphia). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 419-428(Apr 1977).

It has been shown, that low-energy proton irradiation does introduce defects into the space-charge region which give rise to a recombination current from this region, although the I-V characteristics are, in this case, dominated by an exponential term which has A = 1. It has further been shown that such a current-voltage relationship results from relatively shallow traps in the space-charge region, and that such traps are, as a minimum, introduced by 70- and 80-keV proton irradiation. The defects introduced by this irradiation are thus different from those originally existent in the solar cells. 18 refs.

11868 Performance of n^+-p silicon solar cells in concentrated sunlight. Burgess, E.L.; Fossum, J.G. (Sandia Lab, Albuquerque, NM). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 433-438(Apr 1977).

Performance data for n^+-p silicon solar cells operating at illuminations up to 90 suns (9 W/cm^2) and temperatures up to 100°C are presented. Experimental results for 2-cm^2 cells with different base resistivities are compared to performances predicted by a numerical device analysis computer code. Excellent agreement between numerical simulation and experiment is observed. 14 refs.

11869 Low-cost solar cells based on large-area unconventional silicon. Fischer, H.; Pschunder, W. (Semiconduct Div, AEG-Telef, Heilbronn, Ger). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 438-442(Apr 1977).

It is the purpose of this paper to present experimental results achieved with the application of a new unconventional nonsingle-crystalline silicon material for solar cell fabrication. The impact of the material properties on solar cell performance is evaluated. During this work the formation process of this silicon was optimized with respect to increasing the conversion efficiency of the solar cells. It was also investigated to what extent new processing must be introduced to optimize the efficiency of these new types of solar cells. 8 refs.

11870 Fabrication and characterization of thin-film silicon solar cells on alumina ceramic. Warabisako, T.; Saitoh, T. (Hitachi Ltd, Tokyo, Jpn). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 446-449(Apr 1977).

Dendritic silicon layers are prepared on alumina ceramic by melting and regrowing a CVD Si layer with a BSG encapsulation. Thin-film solar cells fabricated by successive deposition of p- and n^{+-} Si layers on this dendritic silicon exhibit a conversion efficiency of 2.6 percent under AM1 illumination. 5 refs.

11871 Amorphous silicon solar cells. Carlson, D.E. (RCA Lab, Princeton, NJ). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 449-453(Apr 1977).

Amorphous silicon solar cells have been fabricated in several different structures: heterojunctions, p-i-n junctions, and Schottky barrier devices. The procedures used in constructing the various solar cells are discussed, and their photovoltaic properties are compared. At present, the highest conversion efficiency (5.5 percent) has been obtained with a Schottky barrier cell, and this structure appears to offer the best promise of approaching the estimated efficiency limit of approximately 15 %. 12 refs.

11872 Indium--tin-oxide--silicon heterojunction photovoltaic devices. Mizrah, T.; Adler, D. (MIT, Cambridge, Mass). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 458-462(Apr 1977).

Heterojunction photovoltaic devices consisting of RF-sputtered, highly transparent, and conductive indium--tin-oxide (ITO) films deposited onto both amorphous or crystalline Si exhibit photovoltaic energy-conversion efficiencies of the order of 0.01 percent for the 100-mW/cm^2 white light of a tungsten-halogen lamp. The relatively high photoresponse of these devices in the blue-UV spectral region leads to a photovoltaic conversion efficiency of approximately 0.5 percent for monochromatic light of wavelength 40 nm. The ITO-crystalline-Si devices exhibit terrestrial solar-cell efficiencies of the order of 1 percent. The performance of such a cell strongly depends on the insulating interface oxide layer, on the surface-state density, and on the incident-light intensity. A model for the operation of these devices is presented. 20 refs.

11873 Intensity effects in SnO_2—Sii heterojunction solar cells. Thompson, W.G.; Franz, S.L.; Anderson, R.L.; Winn, O.H. (Syracuse Univ, NY). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 463-467(Apr 1977).

The saturated photocurrent of SnO_2—n-Si heterojunction solar cells is found to be linear with illuminaton intensity up to 30 suns of simulated AM1 irradiation. An interfacial layer at the SnO_2—Si junction causes the open-circuit voltage to saturate at a value of light intensity determined by the thickness of this layer. The resistance of this interfacial layer limits the fill factor of these devices. It is shown that the open-circuit voltage depends on an internal diode quality factor rather than on that measured from the terminal I-V characteristics. The internal diode quality factor can be determined from measurements of open-circuit voltage and saturated photocurrent, with illumination intensity as a parameter. 14 refs.

11874 Accelerated life tests of SnO_2—Si heterojunction solar cells. Nash, T.R.; Anderson, R.L. (Syracuse Univ, NY). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 408-472(Apr 1977).

The series resistance of SnO$sub 2$--Si heterojunction solar cells increases with time on-shelf after fabrication, but tends to stabilize after a few weeks. This degradation is enhanced at elevated tempratures. The open-circuit voltage may increase or decrease with time. It is concluded that the degradation results from the spontaneous growth of a high-resistance interfacial layer (probably SiO$sub 2$) at the SnO$sub 2$--Si interface.

11875 Technology of GaAs metal--oxide--semiconductor solar cells. Stirn, R.J.; Yeh, Y.C.M. (Calif Inst of Technol, Pasadena). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 476-483(Apr 1977).

The purpose of this paper is to provide a detailed description of the current technology for fabricating single-crystal AMOS solar cells and to present some preliminary results of the chemistry and electrical characterization of such cells. 13 refs.

11876 Auger analysis of CdS—$CuInSe_2$ thin-film solar cells. Kazmerski, L.L.; Cooper, R.B.; White, F.R.; Merrill, A.J. (Univ of Maine, Orono). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 496-498(Apr 1977).

CdS--$CuInSe_2$ thin-film solar cells are examined by Auger electron spectroscopy. The effects of device fabrication and post-deposition procedures on the depth-compositional profiles and the performance of these photovoltaic devies are presented. The temperature dependence of the grain boundary diffusion coefficient of Cd from the CdS layer into the $CuInSe_2$ film is determined experimentally. 8 refs.

11877 Compound-semiconductor solar cells. I. Katoda, T.; Yamazaki, S.; Kishi, M. *Tokyo Daigaku Uchu Koku Kenkyusho Hokoku;* **13**: No. 1, 231-245(Mar 1977). (In Japanese with English abstract).

In/sub 1-x/Ga/sub x/As solar cells with graded-band gap structure are expected to have a conversion efficiency of up to 29.4%, according to a theoretical calculation. Schottky barrier photocells were prepared by evaporating Au on n-type In/sub 1-x/Ga/sub x/As epitaxial layers grown on n-type GaAs substrates using the In-Ga-AsCl/sub 3/-H/sub 2/ vapor-phase deposition system. The oxide film naturally formed on the surface of In/sub 1-x/Ga/sub x/As was found to influence the barrier height of a Schottky diode made on it. The low conversion efficiency of In/sub 1-x/As solar cells (1%) is considered to be due to the presence of a high-resistivity layer at the interface between the epitaxial layer and the substrate. However, their spectral response is wider than that of solar cells made of GaAs. 7 refs.

11878 Progress in solar cell technology. Treble, F.C. *Electron. Eng.;* **49**: No. 591, 51-53(1977).

Solar cells provide clean, silent, reliable power. Various types under development are considered. The prospects for substantial market growth are assessed. Economic aspects are discussed.

11879 Status of silicon solar cell technology. Brandhorst, H.W. Jr. (NASA, Lewis Res Cent, Cleveland, Ohio). *Jpn. J. Appl. Phys.;* **16**: No. Suppl. 16-1, 399-405(1977).

From 8. conference on solid state devices; Tokyo, Japan (1 Sep 1976).

Major progress in solar cell technology leading to increased efficiency has occurred since 1970. In this time period, cell efficiency has increased by about 50%. Technical approaches leading to this increased output include surface texturizing, improved antireflection coatings, reduced grid pattern area coverage, shallow junctions and back surface fields (e.g., n$sup +$-p-p$sup +$ structures). The status of these developments and their incorporation into cell production is discussed. Future research and technology trends leading to further efficiency increases and substantial cost reductions are described. 18 refs.

11880 Evaluation of SI ribbon crystals for solar cells. Hojo, A.; Ikawa, Y.; Matsui, T.; Nakagawa, M. (Tokyo Shibaura Electr Co, Kawasaki, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. Suppl. 16-1, 407-412(1977).

From 8. conference on solid state devices; Tokyo, Japan (1 Sep 1976).

Defect structures, electrical properties of the Si ribbon crystals were investigated. Performances of Si ribbon solar cells were also measured. It was found that twin boundaries did not degrade the electrical properties, whereas irregular boundaries deteriorated the minority carrier lifetime appreciably. The solar cells fabricated from the ribbon crystals did not show inferior properties in spite of the existence of the defects in the crystals when the surface contact was kept off the SiC particles embedded in the ribbon surface. 7 refs.

11881 Dendritic growth of silicon thin films on alumina ceramic and their application to solar cells. Saitoh, T.; Warabisako, T.; Itoh, H.; Nakamura, N.; Tamura, H.; Minagawa, S.; Tokuyama, T. (Hitachi Ltd, Cent Res Lab, Tokyo, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. Suppl. 16-1, 413-416(1977).

From 8. conference on slid state devices; Tokyo, Japan (1 Sep 1976).

Polycrystalline silicon films on alumina ceramic are recrystallized under normal freezing conditions. A multi-layered structure containing borisilicate glass and titanium layers is successfully used to prevent molten silicon films from agglomeration. The films obtained are dendritic and of mm size. Chemical etching reveals tilt boundaries, linear and dot-like defects in addition to grain boundaries. The thin film solar cells fabricated on the recrystallized silicon by successive deposition of p and n/sup +/ layers show photovoltaic conversion efficiencies of up to 2.6% at a fill factor of 0.67 under an AM1 simulator. The electron diffusion length of the p-type active layers is μm and causes a low short circuit current density of 9.8 mA/cm^2. 8 refs.

11882 Analysis of silicon solar cells with multi-layer structure. Matsushita, T.; Miyake, M.; Mamine, T. (Sony Corp, Asahi, Atsugi, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. Suppl. 16-1, 423-426(1977).

From 8. conference on solid state devices; Tokyo, Japan (1 Sep 1976).

The multi-layer silicon solar cells have been theoretically analyzed at AM O by a simplified one dimensional first order solar cell model, which neglects depletion region recombination, high injection and drift currents. It is shown that the six-layer solar cell is an optimum structure. The six-layer solar cell is compared with the conventional p^+-n solar cell and the back-surface field (BSF) p^+-n-n^+ solar cell. It is proven that the multi-layer solar cells can show still higher conversion efficiencies than the BSF solar cell and the conversion efficiency can approach about 21% at AM O. 3 refs.

11883 Photovoltaic characteristics of photocells by ionized-cluster beam deposition and epitaxy. Takagi, T.; Yamada, I.; Sasaki, A.; Itoh, S.; Mori, H.; Morimoto, H.; Kodama, M.; Ozawa, M. (Kyoto Univ, Jpn). *Jpn. J. Appl. Phys.;* **16**: No. Suppl. 16-1, 427-431(1977).

From 8. conference on solid state devices; Tokyo, Japan (1 Sep 1976).

The ionized-cluster beam deposition and epitaxial techniques developed by authors, are entirely different from conventional vacuum and sputtering deposition techniques. The principle of these techniques, the pronounced effects on the formation of the film deposited by the ionized-cluster beam, and the characteristics of the film are described, and then photocharacteristics of the p-n junction and the Schottky barrier diodes are discussed in connection with the characteristics of the deposited film. These diodes show improved spectral characteristics, when compared to the diode fabricated with conventional method. The results indicate that the ionized-cluster beam deposition technique can be very useful for the fabrication of a photo-cell. 7 refs.

11884 Transformation behaviour of cuprous sulphides and its application to the efficiency of Cu/sub x/S-CdS solar cells. Putnis, A. (Univ of Cambridge, Engl). *Philos. Mag.;* **34**: No. 6, 1083-1086(Dec 1976).

Recent work on the transformation behaviour of the two cuprous sulphide phases, chalcocite and djurleite, has shown that there need be no compositional difference between them, and that djurleite is the lower free energy phase at room temperatures. The significance of these conclusions is discussed in relation to two problems concerned with Cu/sub x/S-CdS solar cells: the conditions under which the copper sulphide phases form in the topotaxial growth on CdS, and the long-term degradation of these cells. 16 refs.

11885 Electricity from solar energy. Rowe, D.M. *Electr. Rev. (London);* **196**: No. 22, 684-686(6 Jun 1976).

Deriving electricity directly from sunlight is a very expensive process despite the "free" fuel. To become comparable with conventional sources the process will have to become more efficient and the solar cells much cheaper. This article examines what progress has been made.

11886 Solar electric power generation: citations from the NTIS data base. Hundemann, A.S. (Ed.). Springfield, VA; National Technical Information Service (1976). 217p.

Abstracts of Federally-funded research pertaining to terrestrial electric power generation by both direct conversion with solar cells and indirect conversion using solar heat are presented. Topic areas cover equipment design, site surveys, economics, and feasibility studies. Abstracts dealing with solar sea power generation and spacecraft power supplies are excluded. This updated bibliography was prepared by searching the 1964-September 1976 data base of NTIS. It contains 217 abstracts, 89 of which are new entries to the previous edition.

11887 Silicon solar cells: citations from the NTIS data base. Smith, M.F. (ed.). Springfield, VA; National Technical Information Service (1976). 250p.

Federally-funded research on silicon solar cell development related to doping, theory, design, fabrication, cost analysis, radiation effects, photovoltaic effects, semiconducting films, thin films, and coatings are covered. Both terrestrial and space applications are included. This updated bibliography was prepared by searching the 1964-September 1976 data base of NTIS. It contains 250 abstracts, 103 of which are new entries to the previous edition.

11888 Silicon solar cells: citations from the Engineering Index data base. Smith, M.F. (ed.). Springfield, VA; National Technical Information Service (1976). 245p.

Worldwide research on silicon solar cell development, doping, design, costs, and efficiency are cited. Studies on space and terrestrial applications are included. This bibliography was prepared by searching the 1970-September 1976 data base of Engineering Index. It contains 245 abstracts.

11889 Ferranti wins contract to make cheaper solar cells. *Electr. Rev. (London);* **196**: No. 23, 724(13 Jun 1975).

A one year 96,000 pounds contract for the technical and market assessment of terrestrial solar cells has been placed with Ferranti's electronic components division by the Dept. of Industry. The assessment will include the production of 1000 prototype solar cell modules to be installed in a variety of climatic regions around world.

11890 Current status of silicon solar cell technology. Brandhorst, H.W. Jr. New York; Institute of Electrical and Electronics Engineers (1975). 7p.

From IEEE international electron devices meeting; Washington, DC, USA (1 Dec 1975).

Recent advances in solar cell technology have led to the development of laboratory cells with efficiencies above 15 percent and production cells with efficiencies in the area of 13 percent. The increased output is largely the result of increases in the short-circuit current. The most significant gain in the amount of light entering the cell has been obtained through surface texturing by chemical etching techniques. Sheet resistances resulting from phosphorus diffusion in the 800°C temperatue range yield junction depths on the order of 0.1 micrometer, leading to significant increases in the blue region of the cell spectral response. The inclusion of a back surface field in 10 ohm-cm cells has produced an increase in open-circuit voltage of about 50 mV and an increase in the minority carrier lifetime. It appears that a low emitter efficiency of the diffused region is the cause of poor voltages. Future research will be primarily directed toward correcting this deficiency and toward the development of low cost production methods.

11891 Characteristics of the equatorial scheme of rotation of solar arrays with a rotation-regulating mechanism. Grigorian, R.S.; Shermiazanian, Ya.T.; Simoniants, A.A. *Geliotekhnika;* No. 5, 24-29(1975). (In Russian).

The effectiveness of equatorial schemes of rotation of solar arrays is investigated with mechanisms for ensuring that the rotation about an axis parallel to the earth axis be with constant angular velocity. This ensures the optical tracking of the equatorial motion of the sun by the solar array. The effects of atmospheric refraction and of the variability of solar day duration on the angular velocity of the observed equatorial motion of the sun are considered.

BIOMASS PRODUCTION AND CONVERSION

11892 (BMI—1957(Vol.2)) **Systems study of fuels from sugarcane, sweet sorghum, and sugar beets. Volume II. Agricultural considerations. Task 77, final report.** Lipinsky, E.S.; McClure, T.A.; Nathan, R.A.; Anderson, T.L.; Sheppard, W.J.; Lawhon, W.T. (Battelle Columbus Labs., Ohio (USA)). 31 Dec 1976. Contract W-7405-ENG-92. 255p. Dep. NTIS, PC A12/MF A01.

The principal findings of the agricultural aspects of the sugar crops research program are summarized. Sugarcane, sugar beets, and sweet sorghum were studied as to their respective production methods, geographical areas in which the crops can be grown, yields, composition, costs, and energy budgets. Sugarcane culture practices

in Florida, Louisiana, Texas, Hawaii, and Puerto Rico are compared. Salient factors in production of sugar beets are summarized. The state-of-the-art for sweet sorghum is also presented. The yields of sugarcane with respect to fresh material, dry matter, fermentable solids, and combustible organic products are summarized. The sugar beet product yields and total production by states is presented. Estimates of the yields of sweet sorghum are also included. The present commercial yields of the sugar crops in each agricultural region are far below those obtained under experimental conditions. Comparison of current estimated costs of sugarcane, sugar beets, and sweet sorghum products with prices that would be desired by purchasers interested in the production of fuels and chemical feedstocks is presented. The energy balance between the energy content of the biomass and the fuels required to manufacture this biomass is presented. Speculative forecasts of sugarcane and sweet sorghum production in the years 1985 and 2000, under alternative scenarios, are shown. Potential production of selected chemicals from sugarcane crop products in the year 2000, in a "critical need" scenario is shown. Speculative forecasts of the cost of fermentable solids and combustible organic material derived from sugarcane and sweet sorghum are shown.

11893 (COO/2917—3(Vol.1)) **Biological conversion of organic refuse to methane. Final report, July 1, 1973—November 30, 1976.** Brown, J.W.; Pfeffer, J.T.; Liebman, J.C. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). Nov 1976. Contract EY-76-S-02-2917. 201p. Dep. NTIS, PC A10/MF A01.

In order to predict accurately the cost of producing methane from urban refuse, studies were initiated on the dewatering of the fermentor residue and the disposal of the residue from the system. Results of the research are reported under the following subject headings: fermentation system; rheological properties of reactor slurry; filterability of reactor effluent; residue dewatering—vacuum filtration; settleability of solids in the reactor effluent; settleability of sludges from centrate treatment; centrifugation of reactor effluent; leachate potential of dewatered reactor residue; calorific value of the reactor residue; residue incineration; the production of panelboards; caustic treatment of digester feed; and, treatment of filtrate—centrate. Appendixes A, B, D, and E are included; Appendix C, which includes computer programs and documentation, is bound separately as Volume II of this report. (JGB)

11894 (COO/2991—8) **Fuel gas production from animal waste: Phase I. Quarterly progress report (2nd), September 1, 1976—December 1, 1976. Dynatech report No 1556.** Ashare, E.; Wentworth, R.L.; Wise, D.L.; Augenstein, D.C. (Dynatech R/D Co., Cambridge, Mass. (USA)). 8 Dec 1976. Contract EY-76-C-02-2991. 10p. Dep. NTIS, PC A02/MF A01.

During this second quarter, meetings were held with contractors on the ERDA Fuel Gas from Animal Waste Program to discuss project planning and review. Site visits were made to groups involved in anaerobic digestion. An engineering and economic analysis of a process for the anaerobic digestion of animal residue was completed; the results can be used for the design of a pilot plant unit. A comprehensive engineering report of this analysis was completed, and a first draft was submitted to ERDA. Several proposals were received from ERDA and reviewed.

11895 (COO/2991—10) **Fuel gas production from animal residue. Dynatech report No. 1551.** Ashare, E.; Wise, D.L.; Wentworth, R.L. (Dynatech R/D Co., Cambridge, Mass. (USA)). 14 Jan 1977. Contract EY-76-C-02-2991. 210p. Dep. NTIS, PC A10/MF A01.

A comprehensive mathematical model description of anaerobic digestion of animal residues was developed, taking into account material and energy balances, kinetics, and economics of the process. The model has the flexibility to be applicable to residues from any size or type of animal husbandry operation. A computer program was written for this model and includes a routine for optimization to minimum unit gas cost, with the optimization variables being digester temperature, retention time, and influent volatile solids concentration. The computer program was used to determine the optimum base-line process conditions and economics for fuel gas production via anaerobic digestion of residues from a 10,000 head environmental beef feedlot. This feedlot at the conditions for minimum unit gas cost will produce 300 MCF/day of methane at a cost of $5.17/MCF ($CH_4$), with a total capital requirement of $1,165,000, a total capital investment of $694,000, and an annual average net operating cost of $370,000. The major contributions to this unit gas cost are due to labor (37 percent), raw manure (11 percent), power for gas compression (10 percent), and digester cost (13 percent). A conceptual design of an anaerobic digestion process for the baseline conditions is presented. A sensitivity analysis of the unit gas cost to changes in the major contributions to unit gas cost was performed, and the results of this analysis indicate areas in the anaerobic digestion system design where reasonable improvements could be expected so as to produce gas at an economically feasible cost. This sensitivity analysis includes the effects on unit gas cost of feedlot size and type, digester type, digester operating conditions, and economic input data.

11896 (COO/4124—1) **Steam gasification of biomass. Progress report.** (Wright-Malta, Inc., Ballston Spa, N.Y. (USA)). 11 Mar 1977. Contract EY-76-C-02-4124. 7p. Dep. NTIS, PC A02/MF A01.

Changes in the design of the research gasifier are described. A sketch of the equipment and a flowsheet of the process to be used for experiments on parameters of feed rate, particle size, pressure, temperature, type of biomass, and catalysts are included. (JGB)

11897 (COO/4124—3) **Steam gasification of biomass.** (Wright-Malta, Inc., Ballston Spa, N.Y. (USA)). 20 Jul 1977. Contract EY-76-C-02-4124. 6p. Dep. NTIS, PC A02/MF A01.

Construction of experimental equipment for research on basic parameters involved in the steam gasification of biomass was completed. Modifications were made on the equipment to improve performance. Information obtained from preliminary runs indicated that intermediate liquids and tars are converted to fuel gas within the time/temperature profile of the biogasifier. Another significant finding is that pressure has little effect on gas composition. (JGB)

11898 (COO/4147—1) **Bioconversion of plant biomass to ethanol. First bimonthly and quarterly report.** (General Electric Co., Schenectady, N.Y. (USA). Research and Development Center). 1977. Contract EG-77-C-02-4147. 5p. Dep. NTIS, PC A02/MF A01.

Research progress is reported in the development of an all-biological two-stage process for converting plant biomass into ethanol. The first stage will consist of a high-solids biomass pretreatment with a thermo-tolerant mold to remove sufficient lignin to make the cellulose available for saccharification. The second stage consists of a mixed culture fermentation and ethanol production using a thermo-tolerant anaerobic sporocytophaga to hydrolyze cellulose and a compatible thermo-tolerant bacillus to convert the soluble sugars formed during saccharification into ethanol. Initial studies on nutritional requirements of various thermophilic organisms and ethanol production are reported. (JGB)

11899 (ERDA/USN/1027—2) **Ocean Food and Energy Farm Project. Subtask 3. Dispersion and sinking studies for oceanic upwelling. Progress report.** (Naval Undersea Center, San Diego, Calif. (USA)). 1976. Contract EY-76-A-03-1027. 64p. Dep. NTIS, PC A04/MF A01.

The three parts of this report were abstracted and indexed individually for ERA/EDB. (JGB)

11900 (ERDA/USN/1027—2, pp 1-40) **Upwelling nutrient plume path, size and concentration for the ocean farm project.** Kirchhoff, R.H. 1976.

In Ocean Food and Energy Farm Project. Subtask 3. Dispersion and sinking studies for oceanic upwelling. Progress report.

Theoretical studies on the upwelling of deep, nutrient-rich ocean water to the surface for kelp nutrification are reported. Four cases of nutrient plume motion were considered: an axisymmetric plume with and without ambient stratification, and a two-dimensional ribbon source with and without ambient stratification. Details of the derivation and solution of related equations are included. (JGB)

11901 (ERDA/USN/1027—2, pp 41-50) **Study of the fate of upwelled water.** Seligman, P.F. 1976.

In Ocean Food and Energy Farm Project. Subtask 3. Dispersion and sinking studies for oceanic upwelling. Progress report.

The dispersion pattern of upwelled water released at the sea surface was studied off Corona del Mar, CA. The horizontal dispersion and vertical sinking rates of water pumped from 1000 ft were measured by fluorometric techniques using Rhodamine B dye as the watermass tracer. Results indicate that water upwelled from 1000 ft has a very slow sinking rate, and the bulk of the deep water remains in the upper 10 ft of the water column for at least 30 min. These initial experiments demonstrate that artificially upwelled water, under the conditions described, has a near surface residence time of sufficient duration to fertilize a relatively large area before sinking below its usable depth. Results of these studies compare favorably with those reported in part 3 of this report. (JGB)

11902 (ERDA/USN/1027—2, pp 51-54) **Observations on the dispersion and sinking of artificially upwelled water in the Pacific Ocean near Crystal Cove, California.** North, W.J. 1976.

In Ocean Food and Energy Farm Project. Subtask 3. Dispersion and sinking studies for oceanic upwelling. Progress report.

The fate of artificially upwelled water was assessed by fluorescein dye tracer at the Crystal Cove Kelp Grid in water 155 ft deep. Under the established experimental conditions artificially upwelled water moved rapidly toward the surface. Lateral dispersion occurred principally in a stratum at the top of the water column. Any sinking was not clearly evident 25 min after dye introduction, although lateral dispersion of about 100 ft had occurred by then. If the upwelled water sinks after dispersal, it does so quite slowly. (JGB)

11903 (ERDA/USN/1027—76(Vol.2)) **Ocean food and energy farm project. Subtask No. 6: systems analysis. Volume 2. Cultivation subsystem. Final report.** Budhraja, V.S. (Integrated Sciences Corp.,

Santa Monica, Calif. (USA)). Jul 1976. Contract E(49-26)-1027. 95p. Dep. NTIS, PC A05/MF A01.

The cultivation subsystem of the Ocean Food and Energy Farm (OFEF) performs all the functions related to the production of kelp. It consists of five major elements, including culturing, planting, substrate, nutrient provisioning, and positioning. The systems and economic analysis of the cultivation subsystem is presented.

11904 (MTR—7347(Vol.1)) **Silvicultural biomass farms. Volume I. Summary.** Inman, R.E. (Mitre Corp., McLean, Va. (USA). METREK Div.). May 1977. Contract EX-76-C-01-2081. 72p. Dep. NTIS, PC A04/MF A01.

Results of a study to assess the potential of wood biomass as a feedstock for producing energy products are summarized in this first volume of the six-volume report. Section titles include: biomass supply, including sub-sections on the silvicultural energy farm, biomass species and productivity, land suitability and availability, site characteristics for site-specific production analyses, energy farm design, biomass production costs, and energy budget for biomass production, and the utility of forestry residues--mill residues and forest residues; biomass conversion, including sub-sections on the future demand for energy products, conversion technologies, prices of wood-derived energy products, and commercial feasibility of wood-derived energy products; needed research on biomass production/procurement and biomass conversion. (JGB)

11905 (MTR—7347(Vol.2)) **Silvicultural biomass farms. Volume II. The biomass potential of short-rotation farms.** Howlett, K.; Gamache, A. (Mitre Corp., McLean, Va. (USA). METREK Div.). May 1977. Contract EX-76-C-01-2081. 162p. Dep. NTIS, PC A08/MF A01.

The management of silvicultural biomass farms was compared with that of timber stands. Suitability criteria were developed and used to identify potential crops for biomass farms. Biomass productivity was evaluated, management practices were identified, and management costs were estimated.

11906 (MTR—7347(Vol.3)) **Silvicultural biomass farms. Volume III. Land suitability and availability.** Salo, D.J.; Inman, R.E.; McGurk, B.J.; Verhoeff, J. (Mitre Corp., McLean, Va. (USA). METREK Div.). May 1977. Contract EX-76-C-01-2081. 225p. Dep. NTIS, PC A10/MF A01.

Land suitability criteria were developed and used to identify potentially available land for silvicultural biomass farms. Six land availability scenarios were chosen for analysis. The annual potential production of biomass energy was estimated on a regional basis assuming the use of 10 percent of the potentially available land in each of the six scenarios and estimated biomass yields. Ten hypothetical biomass farm sites were selected and described.

11907 (MTR—7347(Vol.4)) **Silvicultural biomass farms. Volume IV. Site-specific production studies and cost analyses.** Inman, R.E.; Salo, D.J.; McGurk, B.J. (Mitre Corp., McLean, Va. (USA). METREK Div.). May 1977. Contract EX-76-C-01-2081. 186p. Dep. NTIS, PC A09/MF A01.

The costs of producing silvicultural biomass on intensively managed, short-rotation farms at ten study sites are estimated. Cost estimates are derived by means of a computerized financial model, based on a conceptual production design that identifies the sequence of operations and activities for the farm and the materials and labor required. Site-specific characteristics, requirements and limitations, including biomass yields, are reflected in the design and in the estimated costs. An energy budget for biomass production and a preliminary examination of environmental impacts are also presented.

11908 (MTR—7347(Vol.6)) **Silvicultural biomass farms. Volume VI. Forest and mill residues as potential sources of biomass.** Howlett, K.; Gamache, A. (Mitre Corp., McLean, Va. (USA). METREK Div.; Georgia-Pacific Corp., Portland, Oreg. (USA)). May 1977. Contract EX-76-C01-2081. 144p. Dep. NTIS, PC A07/MF A01.

A study was conducted on the utility of using mill and forest residues as an energy feedstock. A system was developed to determine the quantities of residues that are currently available and to estimate the quantities that might be available in the future. Current selling prices of mill residues were surveyed by residue type and the costs of collecting, reducing, and transporting forest residues were analyzed. Two site-specific situations were examined to determine the competitiveness of residues with conventional fuels within the forest industry.

11909 (SAN/1241—77/1) **Conversion of biomass materials into gaseous products. Phase I. Final technical report, May 25, 1976—June 24, 1977.** Garrett, D.E. (Garrett Energy Research and Engineering, Claremont, Calif. (USA)). Oct 1977. Contract EY-76-C-03-1241. 143p. Dep. NTIS, PC A07/MF A01.

A one year exploratory bench scale pilot plant and laboratory study was completed on the proprietary Garrett Energy Research and Engineering Co., Inc. double effect dryer-multiple hearth biomass pyrolysis process. The results indicate that an initial vacuum drying stage is quite feasible, and that an effective overall heat transfer coefficient of 4.5 Btu/hr x sq. ft. x °F can be obtained for the flue gas-vacuum dryer. Direct contact drying was also efficiently conducted in the hearths, with an effective overall drying rate for manure of about 5 lbs water/hr x cu. ft. of hearth space. Acceptably low solids entrainment and lack of hearth plugging occurred at a flue gas velocity of 0.1 ft/sec, and 60 ft/sec through the base plate holes. Pyrolysis commenced with manure at 250°C (mostly CO_2 evolved), but was not highly efficient until temperatures of over 700°C were reached. This char-water gas reaction was most effective at temperatures above 900°C with about six seconds contact time. Combustion of the char was rapid and controllable at 2000°C. The 450 Btu/ft^3 (dry, CO_2-free) product gas was obtained in about a 74 percent yield, was low in carbon monoxide, and should be blendable into natural gas pipelines. The data indicated that a 100 t/d (dry basis) manure processing plant could be built for about $1.9 million, and produce a medium Btu gas for $2.84/MMBtu if manure is free, after all costs, depreciation, and a 10 percent return on investment.

11910 **Energy production by microbial photosynthesis.** Benemann, J.R. (Univ. of California, Berkeley); Weissman, J.C.; Koopman, B.L.; Oswald, W.J. *Nature (London);* **268**: 19-23(7 Jul 1977).

The large amounts of microalgae produced in waste treatment ponds during sewage purification are a potential source of methane and fertilizer. If techniques can be developed for the selective cultivation of filamentous or colonial microalgae, harvesting of microalgal biomass could be accomplished by low-cost straining or sedimentation methods. Problems of algal harvesting, species control, bioconversion, and algal productivity are discussed.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 11795

11911 **Power conversion efficiency of the gold-rhodamine b-bold photoelectrochemical cell/gold.** Quickenden, T.I.; Yim, G.K. (Univ. of Western Australia, Nedlands). *Sol. Energy;* **19**: No. 3, 283-289(Oct 1977).

The power conversion efficiency of the photoelectrochemical cell Au—Rhodamine B—Au was found to be $(2.4 +- 0.2) \times 10^{-6}$ percent under typical operating conditions. A ten-fold improvement could be expected from constructional modifications, but further increases in efficiency would require changes in the cell chemistry. The low power conversion efficiency can be related to a low (4.7×10^{-2} percent) efficiency for the production of the open circuit photovoltage; a low (2.2×10^{-2} percent) quantum efficiency for the production of the short circuit current; and to markedly non-rectangular voltage-current characteristics. The deviations from a rectangular relationship and the low efficiency of current production arise from mass-transport limitations rather than from ohmic losses or activation polarisation. The low voltage efficiency probably arises from inefficiencies in the photochemical and electron transfer steps which lead to photovoltage production. The limitations of this type of cell as a solar energy conversion device are discussed. 40 references.

11912 **Stable photo-electrochemical solar cell employing a CdSe photoanode.** Gerrard, W.A.; Owen, J.R. (Mater and Energy Res Cent, Tehran, Iran). *Mater. Res. Bull.;* **12**: No. 7, 677-684(Jul 1977).

Low-temperature methods of producing thin coatings of cadmium selenide on a steel substrate are described. These coatings are suitable for solar to electrical energy conversion and have been used in a photoelectrochemical cell employing a cadmium selenide-stabilizing redox couple, which converts sunlight to electricity at a 1% power conversion efficiency without deterioration of the CdSe photoanode. Possible improvements in the coating quality and cell design are considered, and the eventual attainment of a 4% conversion efficiency is considered feasible. 11 refs.

11913 **Semiconductor-electrolyte photovoltaic cells employing CdSe and CdTe.** Chai, Y.G.; Anderson, W.W.; Anderson, L.B. (Ohio State Univ, Columbus). *IEEE Trans. Electron Devices;* **ED-24**: No. 4, 492-496(Apr 1977).

Cadmium selenide and cadmium telluride have been studied in photovoltaic cells constructed of single crystal semiconductor materials in contact with electrolyte solutions. Cadmium selenide shows an open-circuit voltage near 0.8 V and power conversion efficiencies near 6 percent for 720-nm light. The CdTe cells did not show current-voltage characteristics favorable for solar cell application. Formation of a surface film of tellurium apparently degrades the photovoltaic properties on illumination.

PHOTOVOLTAIC POWER PLANTS

11914 (ERDA/JPL/954698—77/1) **Engineering study of the module/array interface for large terrestrial photovoltaic arrays. Final report.** (Bechtel Corp., San Francisco, Calif. (USA)). Jun 1977. Contract NAS-7-100-954698. 164p. Dep. NTIS, PC A08/MF A01.

Several factors contributing to the design of photovoltaic panels and their interface with the array were studied. The study's emphasis was on large arrays, with a 200 MW central station power plant used for the baseline. Three major areas—structural, electrical, and maintenance—were evaluated. Efforts in the structural area included establishing acceptance criteria for materials and members, determining loading criteria, and analyzing glass modules in various framing system configurations. Array support structure design was addressed briefly. Electrical considerations included evaluation of module characteristics, intermodule connectors, array wiring, converters and lightning protection. Plant maintenance features such as array cleaning, failure detection, and module installation and replacement were addressed.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 11825, 11826, 11886

11915 **Solar to electrical energy converting system.** Brinjevec, H.J. US Patent 4,047,385. 13 Sep 1977. Priority date 25 Sep 1975, Canada. 4p.

This energy system comprises a metal sphere equipped on the outside thereof with two centrally located arc-shaped and pivoted arms which meet on the top of the sphere and are joined by means of a spring loaded connection. Each of said arms consists of a bank of spaced convex lenses which focus the rays of the sun into intensely hot focal points on the surface of the sphere. Inside the sphere are coils of pipe containing water which is converted to steam by means of a heating liquid in which these pipes are immersed, so that the heating liquid which is heated by the surface of the sphere in turn heats the coiled pipe changing the contained water to steam. The steam is fed to an engine or turbine which in turn powers a dynamo which supplies electrical power. The heating fluid inside the sphere also circulates through a furnace which takes over the heating of the liquid during the absence of the sun's rays. Heat sensing devices spread the arms from the sphere when it becomes overheated beyond a predetermined temperature. In addition the system is provided with the usual control valves, thermostats, and a heat exchanger.

11916 **Solar radiation collector and system for converting and storing collected solar energy.** Arthur, D.M. US Patent 4,010,614. 8 Mar 1977. Filed date 13 Nov 1974. 12p.

A system is disclosed for converting solar radiation into electricity and for storing energy generated in excess of demand. The system includes a large circular collector fabricated from modular elements. The collector is combined with a concentrator and boiler for producing steam. The steam produced is used to drive an electrical generator and a hydraulic pump. When system demand is less than the capacity of the generator, the excess energy is used to drive the pump. The pump transports water from a low level reservoir to an elevated reservoir, thereby storing potential energy. Later, when demand increases, water from the elevated reservoir is used to drive a second electrical generator. The circular collector is mounted on tracking apparatus which automatically aims the collector to focus on the sun and receive maximum solar radiation on its surface.

11917 **Floating concentrating reflectors for solar energy power plants.** Rasch, C. German(FRG) Patent 2,524,356/A/. 16 Dec 1976. 41p. (In German).

A concave mirror arrangement for a solar energy power plant is described. The concave mirrors have a rectangular plan and are mounted on individual bearings so as to rotate on a horizontal axis in the vertical direction. One or more such series of mirrors are mounted on a floating foundation and can be turned on this in the horizontal plane.

CENTRAL RECEIVER

11918 (LBL—6329) **Central receiver power plant: an environmental, ecological, and socioeconomic analysis.** Davison, M.; Grether, D. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 150p. Dep. NTIS, PC A07/MF A01.

The technical details of the central receiver design are reviewed. Socio-economic questions are considered including: market penetration, air industrial sector model, demands on industry, employment, effluents associated with manufacture of components, strains due to intensive construction, water requirements, and land requirements. The ecological effects in the vicinity of the central receiver plant site are dealt with, with emphasis on effects on land surface, mammals, and reptiles and amphibians. Climatological considerations are reviewed including: desert types, effects of surface albedo modification, effects of aerosols, effects on evaporation rates, the heliostat canopy, effects on turbulent transfer rates, effects on the wind profile, a model of convection about a central receiver plant, and a global scenario. Drawings of heliostat and plant design are included in appendices. (MHR)

11919 (SAN/1109—8/1) **Solar Pilot Plant, Phase I. Preliminary design report. Volume I. Executive overview (approved). CDRL item 2.** (Honeywell, Inc., Minneapolis, Minn. (USA). Energy Resources Center). 1 Aug 1977. Contract EY-76-C-03-1109. 105p. Dep. NTIS, PC A06/MF A01.

The project goals, program schedules, and preliminary design for the 10 MW central receiver pilot plant at Barstow, California are presented. Details of the collector field, receiver/tower, thermal storage system, electrical power conversion subsystem, and control systems are given. (WHK)

11920 (SAN/1111—8/1) **Central Receiver Solar Thermal Power System Pilot Plant preliminary design report. Collector subsystem. Executive summary. Volume 1.** (Boeing Engineering and Construction, Seattle, Wash. (USA)). 29 Apr 1977. Contract EY-76-C-03-1111. 39p. Dep. NTIS, PC A03/MF A01.

This summary covers the project schedule; field geometry and performance, collector subsystem configuration; manufacturing, installation, and checkout; safety, reliability, and maintainability; and test program. (MHR)

11921 **Solar flux density calculation for a solar tower concentrator using a two-dimensional hermite function expansion.** Walzel, M.D.; Lipps, F.W.; Vant-Hull, L.L. (Univ. of Houston, TX). *Sol. Energy;* **19**: No. 3, 239-253(Oct 1977).

The calculation of flux density on the central receiver due to a large number of flat polygonal reflectors having various orientations is a basic part of the system simulation problem for the tower concept of solar energy collection. A two-dimensional Hermite function expansion is adapted to the simulation problem, and numerical results are contrasted with an analytic integration of the solar flux density at specific nodes on an image plane. Various measures of error in the flux density calculation are monitored vs. distance to the image plane and orientation of the reflector. The flux densities predicted by the statistical method compare favorably with those of the analytic model and require approximately one-tenth the computer time.

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 12542

11922 (COO/2641—4) **Heat transfer research and power cycle transient modeling.** Rothfus, R.R.; Neuman, C.P. (Carnegie Inst. of Tech., Pittsburgh, Pa. (USA). Dept. of Chemistry). 23 Mar 1977. Contract EY-76-S-02-2641. 102p. (CONF-770331—3). Dep. NTIS, PC A06/MF A01.

From 4. ocean thermal energy conversion conference; New Orleans, LA, USA (22 Mar 1977).

Fine axial flutes enhance heat transfer in vertical shell-and-tube exchangers with water inside the tubes and ammonia evaporating or condensing in layer flow on the shell side. Single-tube experiments with R-11 and ammonia indicate local shell-side coefficients 3 to 5 times those for corresponding smooth tubes. Single-tube experiments with water indicate that at moderate velocities the tube-side coefficients are enhanced by a factor equal to the ratio of fluted-to-smooth surface areas while the fluid friction is similarly increased. The experimental data are transformed into mean individual coefficients for ammonia and water. Overall coefficients for a particular case are presented to illustrate the efficacy of enhancement by flutes on one or both sides of the heat transfer surface. Means are described for using emerging data to predict the static and dynamic behavior of the power cycle and the interactions of components throughout the complete power plant.

11923 (TID—27746) **Abatement of biofouling and corrosion in OTEC heat exchangers using low energy surfaces. Final technical report, May 1, 1975—February 29, 1976.** Ostrozynski, R.L.; Jones, P.E. (Allied Chemical Corp., Buffalo, N.Y. (USA). Specialty Chemical Div.). Jun 1976. Contract EY-76-C-02-2692. 334p. Dep. NTIS, PC A15/MF A01.

The economic viability of OTEC as a means of harnessing solar thermal energy depends on the ability to control marine fouling and corrosion on OTEC heat exchanger surfaces. During the past year under ERDA sponsorship, Allied Chemical Corporation demonstrated the concept that fouling and corrosion are minimized on low energy metal surfaces treated with fluorochemicals without

impairing their heat transport properties. Experimentally, the surfaces of selected metals were chemically modified with a fluorochemical monolayer to minimize their surface energy. The treated metals were then observed for fouling and corrosion in the ocean at Miami, Florida in an attempt to simulate the OTEC operational environment. Antifouling and anticorrosion performance was judged by comparing the extent of barnacle, algae and corrosion coverage of the treated surface to one that was untreated. Other components, viz. tributyltin bearing agents and organoreactive silanes were combined with the fluorochemical in an effort to improve monolayer performance. Lower energy surfaces produced by a fluorochemical monolayer abated algae fouling on aluminum alloy No. 3003-H14 and commercially pure titanium throughout the test period of six weeks. Also, they protected the aluminum and 90/10 copper-nickel alloy No. 706 from seawater corrosion for the same duration. However, barnacle fouling was observed on all panel surfaces. Electron spectroscopic and electron microscopic analysis of the outermost surface pointed to the possible reasons for this growth. Evidently in most instances and particularly on titanium, the surfaces were not covered with a continuous film of monolayer. Moreover, the treatments left the surfaces with a rough texture and hence in a state predisposed to barnacle fouling.

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 11795

11924 (TAC-STC—77-002) **Solar thermal components: a bibliography with abstracts. Quarterly update, April—June 1977.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Jul 1977. 45p. of New Mexico, Albuquerque, NM.

The bibliography contains items on solar components under the headings: material properties, flat-plate collectors, concentrating collectors, thermal storage, heat pumps, coolers/heat exchangers, solar ponds, greenhouses, process heat and irrigation pumps. (MHR)

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 11826, 11845, 11955, 11956, 12661, 12722

11925 (COO/2628—1) **Solar heating and cooling experiment for a school in Atlanta. Design report.** (Westinghouse Electric Corp., Baltimore, Md. (USA)). 1 Dec 1974. Contract EY-76-C-02-2628. 278p. (PB—240611). Dep. NTIS, PC A13/MF A01.

The first large scale integrated system providing heating and cooling for a building utilizing solar energy has been designed for an existing elementary school in Atlanta, Georgia. Solar cooling is provided through the use of a hot water fired lithium bromide absorption chiller to satisfy building cooling loads. Hot water for heating and cooling is provided by a 10,000 sq. ft. solar collector array using reflective surfaces to obtain some concentration during summer months. Approximately 60% of the heating and cooling loads is expected to be met by solar energy, the balance by natural gas. The report contains details of design and principles of operation.

11926 (COO/2688—7) **Solar heating and cooling of buildings: Phase I (non-residential). InterTechnology/Solar Corporation cost/benefit analysis report and supporting opinion survey, commercial buildings. National Solar Demonstration Program, executive summary.** (InterTechnology Corp., Warrenton, Va. (USA)). 28 Oct 1976. Contract EY-76-C-02-2868. 27p. Dep. NTIS, PC A03/MF A01.

A parametric study was performed to provide an estimate of the number of non-residential solar demonstration projects that will be required to start a commercial industry in solar equipment manufacturing, marketing, financing, and installation. An opinion survey was conducted among several experts in the field and results are shown. A techno-economic computer simulation of the solar industry was constructed. This simulation predicts the response of the marketplace to the ERDA program. The computer model showed that ERDA should offer to pay 75% of the initial cost of the system plus 90% of the maintenance and insurance costs over the next 20 years. The predicted response of the marketplace to the ERDA offer of 75%/90% is that 667 demonstration units would be built in all regions of the country, except the region around Seattle, Washington. (MHR)

11927 (ERDA—77-65) **ERDA facilities solar design handbook.** (Energy Research and Development Administration, Washington, D.C. (USA)). Aug 1977. 178p. Dep. NTIS, PC A09/MF A01.

This handbook covers design of solar heating systems for commercial and laboratory buildings at Energy Research and Development Facilities. It includes discussions of solar energy fundamentals, solar heating and cooling technology, systems, and components, as well as a discussion of solar-system economics. Quantitative analysis, with generalized design and sizing curves, is presented for solar heating so that collector and other system parameters can be cost-economically sized without a computer simulation. Solar-system design considerations and guidelines, as well as guidelines for developing subsystem specifications, are presented. Thus, this handbook is both a primer for the solar novice and a reference manual for the solar-system designer.

11928 (SOLAR/0001—77/15) **Instrumentation installation guidelines.** (International Business Machines Corp., Huntsville, Ala. (USA)). 1 Nov 1977. Contract EG-77-C-01-4049. 102p. Dep. NTIS, PC A06/MF A01.

The purpose of this document is to identify and describe the various activities which must be performed in instrumenting solar systems for evaluation of their performance. In addition, this document defines the responsibilities of ERDA, or ERDA's contractors, and the site contractor in the definition and installation of required instrumentation for monitoring solar energy systems. An important goal of the National Solar Data Program is to establish the thermal performance characteristics of residential and commercial demonstration sites and to assure the dissemination of this information to all interested parties. In order to insure that uniform and comparable data are obtained from each solar site, a systematic approach to developing the data requirements, instrumentation techniques, and data analysis methods is being utilized. It is recognized that complete instrumentation and technical evaluation of each solar system/building/climate combination is not practical on all government sponsored solar demonstration sites. Therefore, only selected installations will be instrumented in the various U.S. geographic regions. In order to meet the goals of the National Solar Data Program, carefully defined sensors, clearly defined installation techniques, and detailed utilization procedures are being used to minimize cost, provide uninterrupted scheduling, and reduce operational problems. Through clear communications in which both ERDA, ERDA's contractors, and the site contractor are active participants, a good instrumentation system can be implemented that will render valuable data to all present and future solar systems designers, contractors, and other data users.

11929 **Atypical Mathew solar house at Coos Bay, Oregon.** Reynolds, J.S. (Univ. of Oregon, Eugene); Baker, M.S.; Gray, R.L.; Larson, M.B.; Mathew, H. *Sol. Energy;* **19**: No. 3, 219-232(Oct 1977).

The Mathew solar house in Coos Bay, Oregon, is an atypical solar house in several respects: its location on the cloudy winter Oregon coast, its combination of near-vertical collector and near-horizontal reflector, its unusually large 8,000 gallon storage tank, and its combination of near-identical collectors; one on the house, the other freestanding. The contributions made by solar energy in space heating are assessed. The apparent solar contribution is approached from two directions: (1) calculation of "assumed solar" energy--house heat loss is calculated and known heat contributed by electricity, people and direct solar gain through windows is subtracted; remainder is assumed stored solar energy. (2) calculation of "measured solar" energy—stored solar energy utilized is calculated by measuring the energy provided by the collectors, then adjusting for energy deposited or withdrawn from storage during each month, and for losses to ground from storage. The monthly "assumed solar" is compared to the monthly "measured solar", and reasons for differences are discussed.

11930 **Simulation analysis of passive solar heated buildings: preliminary results.** Balcomb, J.D.; Hedstrom, J.C.; McFarland, R.D. (Univ. of California, Los Alamos). *Sol. Energy;* **19**: No. 3, 277-282(Oct 1977).

Solar gains through windows, walls, modified walls, skylights, clerestory windows, and roof sections provide an opportunity to dramatically reduce the total heating energy requirements of a building. Many such passive solar heating elements are currently available to a designer presenting a large number of possible system designs. A computer simulation analysis has been employed to aid in the selection of components. The results indicate that a performance comparable to that of a conventional active solar heating system should be achievable in an optimized design passive solar heating system. The placement and type of thermal storage is crucial to good performance. Movable insulation of the window increases the performance. When used in conjunction with a conventional heating system, temperature variations in the building can be reduced to those normally experienced.

11931 **Simulation study of several solar heating systems with offpeak auxiliary.** Hughes, P.J.; Duffie, J.A.; Beckman, W.A. (Univ. of Wisconsin, Madison). *Sol. Energy;* **19**: No. 3, 317-319(Oct 1977).

Several off-peak auxiliary solar air heating systems are compared, using simulation methods to determine the best ways of incorporating on-site thermal storage of energy supplied by a utility. Two basic types of off-peak solar systems have been studied; those that isolate and those that combine the storage of auxiliary and solar energy.

11932 Solar pond for London. Bryant, H.C.; Colbeck, I. (Univ. of London, Eng.). *Sol. Energy;* **19**: No. 3, 321-322(Oct 1977).

Formulas which were used to make predictions for several locations in the U.S. were applied to the conditions in southern England, near London. The calculations indicate that a house near London would need a pond area equal to its floor space. (MHR)

11933 Solar heating/cooling system. Worthington, M.N. US Patent 4,049,046. 20 Sep 1977. Filed date 17 Feb 1976. 12p.

A solar heating and cooling system comprising a multi-tiered collector and heat exchanger is described that is mounted on a roof or installed in a vertical wall. Each tier of the exchanger includes a plurality of longitudinal channels with upper and lower manifolds communicating with all of the channels. A duct extends from each manifold into the premises being heated with one duct being connected to an air blower. The exchanger also includes an upper or outer flat metallic sheet with a perforated feed pipe extending across the upper end of this sheet and a drain pipe that communicates with the lower end of this sheet. A heat trap in the form of a transparent sheet is spaced from this sheet. A multidecked, louvered, enclosed evaporator is mounted on the ground over a non-pressurized liquid storage tank with the upper end of the evaporator below the lower end of the exchanger. The upper end of the evaporator is connected to the drain pipe and the storage tank to the feed pipe with a pump being associated with the storage tank and the latter connection. Valves are included in the pipes which connect the evaporator and storage tank to the exchanger and control the direction and flow of liquid to and from the exchanger. A second heat exchanger is submerged in the liquid in the storage tank and is connected to any other equipment requiring liquid at a desired temperature. A float control valve is included in the storage tank to maintain a desired liquid level therein.

11934 Solar assisted heat pump system. Bottum, E.W. US Patent 4,049,407. 20 Sep 1977. Filed date 18 Aug 1976. 8p.

A heating system for a building structure is provided in which a heat pump system and at least one solar energy system and one air convector system are used. The solar energy system collects heat during the periods when sun energy is available and the air convector system collects heat when available from warm air. The heat from both systems is stored directly in the earth which surrounds the evaporator of the heat pump system.

11935 Air conditioning apparatus utilizing solar energy and method. Meckler, G. US Patent 4,011,731. 15 Mar 1977. Filed date 15 Nov 1974. 14p.

An air conditioning apparatus and method are disclosed. The apparatus includes a chemical dehumidifier which employs an aqueous hygroscopic solution of a glycol and a solar energy collector for use in regenerating the solution. Air to be conditioned is circulated through a contactor of the chemical dehumidifier, in contact with cooled glycol solution. Concentrated hygroscopic glycol solution is circulated from a regenerator to the contactor, while dilute solution is circulated from the contactor to the regenerator. Energy from the solar collector is transferred to facilitate concentration thereof. In one disclosed embodient energy from the solar collector is also transferred to the generator of heat-powered refrigeration apparatus, e.g., absorption or rankine engine driven refrigeration apparatus. The condenser of the refrigeration apparatus may operate to heat the glycol solution in the regenerator of the dehumidifier and the evaporator may cool the concentrated glycol solution in the contactor and/or may supply chilled fluid to a heat exchanger for cooling the dehumidified air.

11936 Closed system solar heater. Chayet, E.L. (to Solar Energy Dynamics Corp.). US Patent 4,010,734. 8 Mar 1977. Filed date 10 Mar 1976. 8p.

A solar heating system of the closed type comprises a solar collector, a water storage tank, and water lines therebetween. The solar collector preferably comprises a continuous length of tubing coiled in a helical array of closely adjacent turns, having a water inlet communicating with the outermost turn and a water outlet communicating with the innermost turn. Comparatively cold water is taken from a water outlet adjacent the bottom of the storage tank and is pumped through a line to the water inlet of the solar collector, and heated water is supplied from the solar collector water outlet, together with cold water from an external supply, to a common inlet adjacent the top of the storage tank. The water line between the solar collector water outlet and the tank water inlet includes a U-shaped section disposed external of the tank and having legs at least equal to the height of the tank, to provide a heat trap which minimizes the loss of heat from the tank.

11937 Utilization of solar energy in low temperature regions. Pt. 1. Solar collectors and their use for industrial water heating and swimming pool water heating as well as for space heating. Gnugesser, E.; Mukherjee, S.K. *HLH. Z. Heiz., Lueftung. Klim., Haustech.;* **28**: No. 1, 14-20(1977). (In German).

In the first part of the essay, the authors briefly deal with meteorological data and then with the construction of solar collectors. In the end of this part, several plans of plants are described with examples. In the second part, the authors give an introduction to the profitability calculation for solar plants. This part closes with economic deliberations on the plans described in the first part.

11938 Solar heating for houses, particularly for single-floor houses. Missenard, F.S.A. German(FRG) Patent 2,623,166/A/. 16 Dec 1976. 17p. (In German).

The process is particularly suitable for single level houses (bungalows). The side of the roof facing south is completely made of glass, while the inside of the roof facing north is covered with a reflecting surface. The concrete roof of the ground floor serves as receiver of the solar radiation which reaches it directly or by reflection. A system of pipes in the concrete roof is connected with a thermal store and underfloor heating in the cellar roof. Additional conventional heating takes care of heat requirements, if the solar energy is not sufficient. The whole plant is thermostatically controlled and can be used in summer to cool the house.

11939 Cheaper and improved solar energy storing walls made of glass bricks. Marcus, J. German(FRG) Patent 2,514,440/A/. 21 Oct 1976. 3p. (In German).

The invention concerns the construction of walls using glass bricks, which store solar energy. To fill the glass bricks, calcium chloride or magnesium salts can be used as crystal forming salt solutions. Glass plates can be placed on the walls, consisting of solar energy storing glass bricks, so that air spaces for heat insulation are formed between the glass bricks and the glass plates. The walls, which are several bricks thick, can form air spaces for heat insulation, by the construction of the glass bricks, the bricks being parallel to the outer surfaces.

11940 Informationswerk Sonnenenergie. Bd. 1. Hausheizung - Warmwasserbereitung - Kuehlung - Stromgewinnung. (Information study on solar energy. Vol. 1. Domestic heating - water heating - cooling - electric power generation). Pfriemer, U. (ed.). Muenchen, Germany, F.R.; Pfriemer (1976). 84p. (In German).

This volume, the first of 4, contains up-to-date articles on the topics: solar house heating in modular form, recommendations for private and industrial new buildings, legal questions with solar energy systems, solar height diagrams as aid for securing solar planning data for buildings, sunshine duration and clouding, station networks and observation series on radiation measurement in Germany and solar collectors for the medium air. The publication furthermore contains numerous data on literature.

11941 Possibilities of exploiting solar and terrestrial radiation in certain areas of the world. Trombe, F. *Chauffage - Vent. - Cond.;* **51**: No. 1, 9-24(1975). (In French).

Capture of solar radiation with and without concentration of the radiation, and capture of terrestrial radiation are discussed with illustrative examples. Various solutions for air conditioning of buildings using solar radiation, water heating, water distillation and ice making are discussed. Likely future trends in these fields are outlined.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 11937

WATER HEATING

REFER ALSO TO CITATION(S) 11826, 11925, 11936, 11937, 11941

11942 Floating solar heater for swimming pools. Roberts, M.A. US Patent 4,022,187. 10 May 1977. Filed date 24 Nov 1975. 6p.

A solar heating apparatus is disclosed herein useful as a swimming pool cover whereby the sun's rays can penetrate the apparatus and heat the water therebeneath. The apparatus includes a plurality of individual and separate units of a predetermined geometry which cooperate with each other to cover a given body of water. Each unit includes an upper panel of transparent, plastic material and a bottom panel of opaque, plastic material. The panels are joined at peripheries to provide an integral unit and spacers or ribs are provided to maintain separation between the opposing panel surfaces so that a thermal compartment is defined therebetween. In one form, the bottom panel may be a continuous strip of plactic material shared in common with separate top panels.

11943 Solar heat system for hot water: a profitability estimate. Berndtsson, L.; Lindgren, S. (Wahlings Installationsutveckling, Swed). *VVS - Tidskr. Varme, Vent., Sanit.;* **48**: No. 1, 71-74(Jan 1977). (In Swedish).

Results are presented of a study of economical and engineering prerequisites for the use of solar energy for hot water preparation in an apartment house. The results show that approximately one

half of the yearly energy required for hot water preparation in apartment houses can be covered by utilizing solar heat.

11944 Method for water heating using solar energy. Oeggerli, K. German(FRG) Patent 2,621,300/A/. 25 Nov 1976. 16p. (In German).

The hot water plant consists of solar collectors and two heat stores (one large, one small store) to which the heat carrier medium gives up the heat via heat exchangers. If the outlet temperature of the collectors exeeds 50°C, the two heat exchangers are switched in series. The fluid then flows first through the small heat store then through the large store and back to the collector. If the outlet temperature of the collector is below 50°C, then the small heat store is bypassed. This store can, in addition, be heated by, for example, electrical energy.

11945 Water heating system operated with solar energy. Kuehnert, W. German(FRG) Patent 2,457,258/A/. 10 Jun 1976. 9p. (In German).

A solar heating system is described which consists of flat plate collectors, a heat storage element, and the heating system proper. The collectors consist of blackened metal absorber plates, a glass cover, and a thermal insulation on the rear side. Service water is prepared in a separate boiler. A conventional auxiliary heating system is proposed for winter when the solar radiation is too weak to supply the heat required.

OTHER

REFER ALSO TO CITATION(S) 11941

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 11844, 11845, 11868, 11921, 11924, 11927, 11932, 11933

11946 (ANL-K—77-3855-1) **Conceptual design and analysis of a compound parabolic concentrator collector array.** Teagan, W.P.; Cunningham, D.R. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Aug 1977. Contract W-31-109-ENG-38. 86p. Dep. NTIS, PC A05/MF A01.

Daily performance levels were calculated using typical "sunny day" insolation curves for Albuquerque, New Mexico. Quarterly and annual performance levels for both CPC and parabolic trough collectors were estimated using a computer program which utilizes weather bureau data tapes to specify solar flux and climatic conditions. The results of the analyses were used to size a collector array. Estimates were made for the manufacturing costs of the collector segments and the cost of installing these collectors into a complete array. Both the installed costs and annual thermal performance of the CPC collector array are projected to be comparable to that of more complex and vulnerable parabolic trough collector arrangements. (MHR)

11947 (COO/2971—1) **Natural convection characteristics of flat plate collectors. Progress report.** Randall, K.R.; Wl-Wakil, M.M.; Mitchell, J.W. (Wisconsin Univ., Madison (USA). Engineering Experiment Station). Sep 1977. Contract EY-76-S-02-2971. 58p. Dep. NTIS, PC A04/MF A01.

The results of an experimental investigation into the convective heat losses in large aspect ratio flat-plate solar collectors are described. An experimental study has been undertaken on a specially designed test cell using a 3 inch Mach-Zehnder interferometer. Air at atmospheric pressure was used as the heat-transfer fluid. The experimental results include interferograms which show the thermal boundary layer formations and the temperature profiles. Local temperature profiles have been analyzed through the use of an optical comparator to determine local Nusselt number profiles, which have, in turn, been integrated to give average heat-transfer results. Angles of inclination from the horizontal of 45, 60, 75 and 90 degrees have been investigated. Aspect ratios from 9 to 36 were examined over a Rayleigh number range of 4,000 to 310,000. Finally, heat-transfer correlations have been developed for the prediction of local Nusselt numbers in the starting and departure corners and for the average heat-transfer results as a function of collector tilt angle.

11948 (PNL—2427) **Research and development in solar mirror quality assurance performance. Annual report, April 1977—September 1977.** Coleman, W.J.; Lind, M.A.; Hampton, H.L.; Gordon, N.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 37p. Dep. NTIS, PC A03/MF A01.

A survey of the current technological status of solar reflectors has been initiated for the Energy Research and Development Administration (ERDA). The survey is directed toward the areas of quality assurance and performance of solar mirrors. A program overview is presented, and the initial results of some preliminary studies currently underway are given. More detailed results will be presented as these studies mature. Specific topics that are covered in this report include: (1) An extensive literature survey of the weatherability, durability, and life expectancy of solar materials has been initiated. Some preliminary results of that survey are discussed. (2) General optical degradation effects on solar materials are discussed. (3) Preliminary results of recently initiated studies on the aging of solar materials are presented. The need for careful materials preparation is emphasized. (4) A study which addresses the problem of cleaning of solar reflectors has been initiated. Some preliminary results on cleaning agents are presented. (5) The need for higher accuracy of laboratory instrumentation for aging studies is emphasized. (6) The development activities associated with a low-cost, easy to use instrument to measure specularities are presented.

11949 (Y/DA—7396) **Precision machining (diamond turning) of optical reflectors.** Tunnell, H.A. (Oak Ridge Y-12 Plant, Tenn. (USA)). 21 Sep 1977. Contract W-7405-ENG-26. 7p. (CONF-770953—1). Dep. NTIS, PC A02/MF A01.

From Concentrating solar collector conference; Atlanta, GA, USA (26 Sep 1977).

Diamond turning is a rapidly developing technology being utilized to produce both large and unique optical reflectors in a cost effective manner. The process is especially suited for the high reflectivity metals such as copper, gold, silver, and aluminum. The basic requirements include a single-crystal diamond tool, a high quality and compatible part material, a nondistorting part support technique, the control or compensation of environmental influences, and a machine tool specially designed for super precision tool path control and low vibration. The capabilities of the advanced machine systems developed in the Oak Ridge Y-12 Plant include a broad range of shapes and sizes. Flat or curved reflectors up to 24 inches in diameter have been machined with better than 40 microinch figure accuracy and 2 microinch surface finish, while reflectors up to 78 inches in diameter have been machined with 75 microinches figure accuracy and 3 microinch surface finish. The efficiency and capability of this process to produce large numbers of complex reflectors or precision masters for replication may make it useful in the manufacture of reflectors for future solar energy concentrator systems.

11950 Solar heat collector and storage system. Ceideburg, J.W. US Patent 4,052,975. 11 Oct 1977. Filed date 20 May 1976. 4p.

A solar heat collector and storage system for a residential or other building is provided which comprises an insulated receptacle in the form of a storage tank, which is preferably buried in the ground adjacent to the building, and which contains a liquid solution which has a relatively low freezing point and a relatively high boiling point, and which will not readily evaporate. The liquid solution may, for example, be water and calcium chloride. The liquid solution in the storage tank is pumped to an upper position on the roof of the building, and it is permitted to flow freely over the roof to a lower position, while exposed to the atmosphere, to be heated by the sun during its travel across the roof. The heated liquid solution is collected at the lower position on the roof and returned to the storage tank. The heated liquid solution in the storage tank may be used in any appropriate manner to derive the energy stored in the liquid solution.

11951 Tubeless solar collector. Vataru, M. US Patent 4,052,974. 11 Oct 1977. Filed date 21 Jul 1976. 10p.

An inexpensive, highly efficient, durable, and easy to manufacture solar collector of the flat-plate type is described. The collector includes a heat exchanger having an upper plate, a lower plate, and four triangularly-shaped side plates defining an enclosed chamber, all plates being highly absorbent of solar radiation, the upper plate curving inwardly so that a central portion thereof extends closely adjacent the lower plate along a hot line extending between opposite corners of the collector; and means for conducting a fluid into and out of the chamber, at the remaining corners thereof, on opposed sides of the hot line, so that the fluid flows through the chamber, perpendicular to and in a thin sheet past the hot line, absorbing heat from the upper plate. The collector also includes a frame in which the heat exchanger is supported along the outer edges only in a manner such that light is reflected to the lower plate to increase the efficiency of heat absorption.

11952 Effect of design and operating parameters on the performance of flat plate solar collectors: calculation method and detailed appraisal. Woodman, T.P. (Swiss Federal Inst. of Tech., Zurich). *Sol. Energy;* 19: No. 3, 263-270(Oct 1977).

The engineer is provided with the basic equations for calculating collector performance as a function of design and operating parameters and the method of solution is indicated using a programmable desk calculator. The method is used to investigate the sensitivity of collector output to ambient air temperature, absorber plate temperature and emissivity, wind speed, atmospheric IR radiation and the number of cover plates. An analysis of losses from the absorber plate shows that reduction of radiation losses through reduced emissivity results in an absolute increase in convection

losses, so that in the absence of measures to suppress convection, the attainment of emissivities below about 0.3 is hardly worthwhile. On the other hand, the use of two cover plates instead of one is shown to be nearly always beneficial. Analysis of losses from the outer cover plate shows that changes of the air temperature have a marked effect on the relative importance of radiation and convection as loss mechanisms. Problems connected with the use of the temperature difference between absorber and ambient air as a parameter are also discussed.

11953 Comparison of elliptical and parabolic non-imaging concentrators. Gurnee, E.F. (Dow Chemical Co., Midland, MI). *Sol. Energy;* **19**: No. 3, 323-324(Oct 1977).

A recent paper has described the cross section of an ideal cylindrical concentrator as an elliptical segment, rather than the parabolic segment as described by Winston. A comparison is made between the two shapes, and it is shown that the elliptical cross section does not fulfill the requirements for an ideal cylindrical concentrator.

11954 Solar radiation absorbing material. Googin, J.M.; Schmitt, C.R.; Schreyer, J.M.; Whitehead, H.D. (to Energy Research and Development Administration). US Patent 4,048,980. 20 Sep 1977. Filed date 8 Mar 1976. 12p.

Solar energy absorbing means in solar collectors are provided by a solar selective carbon surface. A solar selective carbon surface is a microporous carbon surface having pores within the range of 0.2 to 2 micrometers. Such a surface is provided in a microporous carbon article by controlling the pore size. A thermally conductive substrate is provided with a solar selective surface by adhering an array of carbon particles in a suitable binder to the substrate, a majority of said particles having diameters within the range of about 0.2-10 microns.

11955 Solar panel assembly for fluid heating and method. Cook, T.E. US Patent 4,046,133. 6 Sep 1977. Filed date 10 Mar 1976. 6p.

A solar panel assembly is described consisting essentially of a heat-collector fluid passage through which the air, for example, to be heated is passed for heating by convection and radiation. The panel comprises a ray-absorbing back or inner panel and a ray-passing diaphanous outer panel which is spaced forwardly thereof to provide the air passage through which the air to be heated is passed. The outer panel is so formed relative to the rear panel that the air passing through the passage is caused to travel in intimate contact with the ray-absorbing panel so that the absorbed heat will be effectively transferred to the passing air. This is accomplished by having the cooperating panels produce successive transverse slots in the direction of flow of the air stream which are constricted to offer resistance to the flow of the air stream to increase its velocity over the ray-absorbing rear panel with a minimum decrease in the pressure of the stream, much like a Venturi tube.

11956 Modular direct solar heat window unit. Arent, A.S. US Patent 4,043,316. 23 Aug 1977. Filed date 5 May 1976. 6p.

A modular direct solar heat window unit is described comprising a vertically disposed frame having a lower window unit at the lower end thereof and a pair of upper window units positioned above the lower window unit. A ventilating window unit is provided in the upper end of the frame. The lower window unit comprises a pair of horizontally spaced and vertically disposed window members with each of the upper window units comprising a pair of window members which are disposed at an angle to the horizontal. A first panel member is hingedly secured at its lower end about a horizontal axis to the frame at the lower end thereof and is movable from a closed position adjacent the lower window unit to an open position. In the closed position, the first panel member protects and insulates the lower window unit. In the open position, the reflective inner surface of the first panel member reflects the rays of the sun into the lower window unit which has a solar heat collector positioned inwardly thereof. The first panel member is adjustably positioned in various positions relative to the lower window unit. A second panel member is hingedly secured about a horizontal axis to the upper end of the frame and is movable from a closed position adjacent the upper window units to an open position. In the closed position, the second panel member protects and insulates the upper window units. The second panel member is adjustably positioned in various open positions to provide varying amounts of shade to the upper window units as required. The inner surface of the second panel member is also provided with a reflective surface to enable the second panel member to also reflect rays of the sun onto the lower window units when the second panel member is properly positioned.

11957 High efficiency solar collector. Cohen, J.M.; Cohen, M.D. US Patent 4,022,188. 10 May 1977. Filed date 5 Apr 1976. 8p.

A novel type of solar collector apparatus is disclosed which comprises a generally planar, horizontally extending absorber having a radiation-accepting aperture in the lower surface thereof, and a duct extending therethrough for receiving a heat transfer fluid. A nonsteered reflector is disposed directly beneath the absorber, the reflector exhibiting a cross-sectional configuration of a parabolic cylindrical nature.

11958 Lateral lens arrangement for solar energy conversion devices. Anderson, D.E. (to Sheldahl, Inc.). US Patent 4,022,184. 10 May 1977. Filed date 10 Mar 1975. 14p.

A solar heat concentrator is described comprising, in combination, solar radiation concentrator means and absorber means for converting the concentrated solar energy into usable form. The concentrator means is essentially a line focus Fresnel array, and includes a plurality of generally parallelly disposed elongated self-supporting elements with reflective surfaces, each element having means for positioning the reflective surfaces in an operative solar viewing disposition, as well as in an inoperative or idle disposition wherein the reflective surfaces are protected from adverse affects due to the elements, including wind, dust, hail, and the like. The radiation absorber means includes an elongated fluid transfer duct of closed cross-section such as an elongated cylinder, with the axis of the fluid transfer duct being generally parallel to the longitudinal axis of the array of reflective surfaces, and with the peripheral surface of the fluid transfer duct having an energy adsorptive zone viewing the concentrator means at substantially the focal point of the concentrator, the balance of the peripheral surface of the absorber being thermally insulated.

11959 Solar energy collecting system. Broberg, F.N. US Patent 4,020,827. 3 May 1977. Filed date 20 Aug 1975. 10p.

A solar energy collecting system is described, which may be operated to provide usable energy throughout the year, comprises a plurality of rows of elongate radiant solar energy collecting panels, each having upper and lower edges, being mounted to form an angle to the horizon and to face the sun's position at solar noon. An elongate reflector, also having upper and lower edges, compliments each row of collector panels to reflect radiant solar energy to it. The upper edge of each row of collector panels is positioned adjacent the upper edge of a reflector to define a single, inverted, generally V-shaped peak. The lower edge of each collector which forms a part of one peak is spaced from the lower edge of the reflector which forms a part of an adjacent peak to define a valley. A walkway is constructed in each valley to provide access to both the reflectors and collector panels for damage and maintenance.

11960 Solar energy system. Mole, R.A. US Patent 4,020,826. 3 May 1977. Filed date 23 Feb 1976. 4p.

A solar energy system is described for selectively absorbing or reflecting radiant energy entering through a window of a structure, the system comprising a window drape having a decorative side and a back side, and a removable liner adjacent the backside of the window drape. At least one side of the liner or window drape backside is a radiant energy reflecting surface and another of said sides is a radiant energy absorbing surface. Thus, depending upon the season of the year, the system may be arranged to selectively provide the appropriate surface to optimize or minimize the radiant energy maintained within the structure.

11961 Collecting solar energy. Cummings, R.D. (to Daystar Corp.). US Patent 4,019,496. 26 Apr 1977. Filed date 7 Apr 1975. 4p.

A solar-to-thermal energy converter is described comprising an insulated frame, a solar energy absorber mounted in the frame, fluid flow heat exchanger means thermally coupled to the absorber to carry away as thermal energy the absorbed solar energy, and a window transmissive to solar energy mounted in the frame and spaced from the absorber. That improvement consists of a heat loss suppressor comprising a multiplicity of walls extending between the window and the absorber, adjacent walls being at least in part non-parallel to each other to define a first set of elongated channels generally diverging and opening toward the window interleaved with a second set of elongated channels generally diverging and opening toward the absorber. The walls are of material transmissive to solar energy and absorptive of thermal energy. The channels are narrow enough to reduce conversion heat loss and deep enough to reduce radiation heat loss.

11962 Equipment for generating useful heat from solar radiation. Grundmann, E.; Heitland, H.; Kroll, R. (to Volkswagenwerk A.G., Wolfsburg (Germany, F.R.)). German(FRG) Patent 2,540,495/A/. 31 Mar 1977. 5p. (In German).

A device for generating utilizable heat from solar energy is described. The device consists of a piping system through which a heat transfer medium flows. The pipes are flexible tubes, the cover of which consists of two coatings. The inner coating absorbes the sun rays, the outer surface consists of translucent material which prevents the dissipation of the absorbed heat to the outside.

11963 Solar collector. Pei, Yu. K. (to Owens-Illinois, Inc., Toledo, Ohio (USA)). German(FRG) Patent 2,542,989/A/. 31 Mar 1977. 27p. (In German).

The invention refers to a solar collector with good efficiency which can be manufactured relatively cheaply. The module con-

struction allows for variable types. The collectors consist of 3 concentrical glass tubes. The outer tube is sealed off towards the inner tube in the middle, the space in between is evacuated so as not to loose heat. The tube in the middle is covered with an energy-absorbing layer of high absorption and low emission. Suitable constructive measures take care of a high heat exchange between absorption layer and heat transfer medium.

11964 Solar collector. Hagarty, R.W. (to Dow Corning Corp., Midland, Mich. (USA)). German(FRG) Patent 2,600,826/A/. 31 Mar 1977. 10p. (In German).

The invention is to facilitate a collector surface of simple design which is to cost little and which has a long span of life. The collector consists of 2 separate, flexible flat-material pieces connected by spacers. The spacers are mounted in such a way that flow ducts for the heat exchange medium are formed. The first piece of flat material consists of transparent silicon material. At least one of the flat-material pieces is reinforced with glass fibres.

11965 Apparatus and method for collecting solar energy at an upright surface. Pedersen, D.W. US Patent 4,014,313. 29 Mar 1977. Filed date 9 Jun 1975. 10p.

This apparatus and method for collection of solar energy is particularly adaptable for being formed as a part of or integrated into an upright or vertical surface of a building or structure. The apparatus involves a closed compartment, including an exterior transparent cover, within which are located energy receiving elements, each having an energy receiving surface oriented to efficiently receive solar energy. The apparatus may also include an interior transparent cover and reflective surfaces for further enhancing the characteristics of the collector, and the interior of the apparatus may be evacuated. The method may include the steps of providing a plurality of radiant energy receiving elements, each having an energy receiving surface at the exterior vertical surface of the building, and orienting the energy receiving surface at an angle for efficiently receiving radiant energy.

11966 Mount for continuously orienting a collector dish in a system adapted to perform both diurnal and seasonal solar tracking. Brantley, L.W.; Lawson, B.D. (to National Aeronautics and Space Administration). US Patent 4,011,854. 15 Mar 1977. Filed date 29 Jan 1976. 6p.

A mount is described for continuously orienting a collector dish relative to the sun in a system adapted to perform both diurnal and seasonal solar tracking. The mount is characterized by a rigid, angulated axle having a linear midportion supporting a collector dish, and oppositely extended end portions normally related to the midportion of the axle and received in spaced journals. The longitudinal axis of symmetry for said midportion of the axle is coincident with a seasonal axis while the axes of the journals are coincident with a diurnal axis paralleling the earth's polar axis. Drive means are provided for periodically displacing the axle about the diurnal axis at a substantially constant rate, while other drive means are provided for periodically indexing the dish through 1° about the seasonal axis, once during each of the earth's successive rotations about its polar axis, whereby the position of the dish relative to the axle is varied for accommodating seasonal tracking as changes in the angle of inclination of the polar axis occurs.

11967 Solar collector. Eshelman, F.R. US Patent 4,011,855. 15 Mar 1977. Filed date 31 May 1974. 6p.

The solar collector of the present invention comprises a light collecting member mounted within a light reflecting member. The light reflecting member includes a surface having a curvature which causes all the light entering therein to be directed toward the light collecting member. In one modification of the device the reflecting member includes two circular surfaces, and in another modification the reflecting member includes a singular circular surface. The light collecting member may be a horizontal flat plate, an elongated member having a center and flanges radiating outwardly therefrom, an elongated circular member, or an elongated vertical plate.

11968 System for use of solar energy. Schenkel, G. German(FRG) Patent 2,531,907/A/. 10 Feb 1977. 17p. (In German).

This is an additional application to P 2510321.3. The main patent is concerned with solar collectors. These collectors are to be developed in the form of units in such a way that the investment in joining elements and the time to be invested in the installation are as small as possible while the thermal efficiency reaches a maximum.

11969 Heating equipment, which is heatable through sunshine. Penschke, W. German(FRG) Patent 2,535,595/A/. 10 Feb 1977. 17p. (In German).

A variation of a flat plate collector is dealt with here. In the casing of the collector, which is thermally insulated, a hollow body is found through which a heat carrier medium flows. The hollow body can be constructed as a heating radiator or as a cooling coil. Through this special construction an enlarged heat attracting surface is obtained. The collector can take over the heating of an entire house, as well as function as an auxiliary heating system at times when there is little sunshine, through the use of an appropriate switch system.

11970 Collector of a solar energy system. Knoche, K.F.; Truemper, H.; Miessen, H. German(FRG) Patent 2,530,782/A/. 27 Jan 1977. 4p. (In German).

The claim refers to the configuration of a solar collector for generating low-temperature heat for space heating purposes. The collector is designed as an evaporator by means of a step construction of the radiation-absorbing surface consisting of trough-shaped steps so that heat losses can be kept down even if the amount of solar radiation is small. A suitable cooling agent can be used instead of water vapor. Furthermore, the vaporization process can be replaced by an evaporation process.

11971 Body for attraction and conduction of heat from sun rays. Kloeckner, E. German(FRG) Patent 2,532,623/A/. 27 Jan 1977. 21p. (In German).

The construction characteristics of a flat plate collector are described. The collector consists of a smooth, thin walled top shell having good heat conduction as an absorber, and a bottom shell. Both shells are provided with raised surfaces in the interior, which guide the flow in such a way that an optimal absorbed heat transfer to the transport medium is accomplished. The collector is equipped with a translucent covering plate.

11972 Design of solar collectors. Looking at types of construction and the calculation. Heinisch, M. *Oel- Gasfeuerung;* **30**: No. 1, 14-18(Jan 1977). (In German).

8 figs.

After an introductory over-view on focussing systems and flat collectors, some physical ground rules which are necessary for an understanding of the effectiveness of solar collectors are discussed. The various losses occurring in collectors are discussed, resulting in a restriction to flat collectors. Finally the useful heat which can be produced is given.

11973 Prediction of radiation absorption and scattering in turbid water bodies. Daniel, K.J.; Laurendeau, N.M.; Incropera, F.P. (GE, Schenectady, NY). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-47, 1-7(1977).

Four different methods for predicting solar radiation transfer in shallow water are considered: a simple version of Beer's law, a representative two-flux model, a six-flux model, and the detailed method of discrete ordinates. The two-flux method was found to be generally the least accurate of those considered, while the six-flux method provided a suitable compromise between accuracy and operational convenience. 24 refs.

11974 Solar collector. Oeggerli, K. German(FRG) Patent 2,621,299/A/. 25 Nov 1976. 12p. (In German).

A flat collector is described. The collector consists of 2 plates, which are welded to one another. The plate turned towards the sun is flat and has a dark mat or selective layer on it. The 2nd plate has a pipe-shaped duct at the upper and lower end and has a number of long cross-pieces at right angles to these ducts. The duct system serves for the flow of the heat transfer medium. The collector plate is covered on the side towards the sun by double glazing. On the back there is heat insulation.

11975 Equipment for absorbing and collecting solar energy. Heilemann, V. German(FRG) Patent 2,620,940/A/. 25 Nov 1976. 19p. (In German).

The solar collector consists of an extensive arrangement of tubes in which the absorption elements are accommodated and which has a transparent outer wall. Each tube can be rotated around its longitudinal axis. Several tubes are combined in a collector unit. The unit itself can also be rotated so that exact adjustment according to the position of the sun is possible. Air is used as heat transport medium.

11976 Sea shell solar collector. Rabl, A. (to Energy Research and Development Administration). US Patent 3,991,740. 16 Nov 1976. Filed date 28 Jul 1975. 4p.

PAT-APPL-599,442.

A device is provided for the collection and concentration of solar radiant energy including a longitudinally extending structure having a wall for directing radiant energy. The wall is parabolic with its focus along a line parallel to an extreme ray of the sun at one solstice and with its axis along a line parallel to an extreme ray of the sun at the other solstice. An energy absorber is positioned to receive the solar energy thereby collected.

11977 Solar energy collector (heat trap). Mertins, K.G. German(FRG) Patent 2,513,327/A/. 21 Oct 1976. 5p. (In German).

The invention relates to a solar energy collector, a weather resistant box thermally insulated on five sides with an exposure area of approximately 0.5 sq.m. The top is covered with glass. Inside the box there is a flat metal case with a surface which absorbs thermal

radiation. This case is passed by a fluid flow. Baffles are installed to avoid dead flow zones. If water is used as the fluid, the collector can be directly hooked onto the filter circuit of a swimming pool and will raise the temperature of the pool water in periods of sunshine.

11978 Equipment for producing useful heat from solar radiation. Grundmann, E.; Kroll, R.; Heitland, H. (to Volkswagenwerk A.G., Wolfsburg (Germany, F.R.)). German(FRG) Patent 2,515,398/A/. 21 Oct 1976. 9p. (In German).

The invention concerns a device for producing useful heat from solar radiation. The device according to the invention is rather similar to an air mattress, which can be rolled up and can easily be transported. It consists of a black sheet turned towards the source of radiation and a second plastic sheet, which are welded together, so that the heat transport medium can flow in a meandering flow path between the two sheets. It is envisaged that the device for heating the water is laid out in a swimming pool on sunny days or on a flat roof.

11979 Absorption plate for solar energy. Gomi, K. German(FRG) Patent 2,513,440/A/. 14 Oct 1976. 8p. (In German).

A solar energy collector is described. The plant consists mainly of an absorber plate made of aluminium, iron or plastic. Specific constructional features are given in detail. Alternatively, the absorber can also be made in the form of a piping system through which a heat transfer medium flows.

11980 Equipment for gaining heat from solar energy. Duerst, F. German(FRG) Patent 2,609,091/A/. 16 Sep 1976. 14p. (In German).

The registration deals with equipment for gaining heat from solar energy. The device does not necessitate any movable parts like follow-up equipment. The heat carrier, for example water, flows through a system of parallel pipes made of heat conducting material, which join a distribution pipe and a collection pipe to each other, which are likewise joined to each other on their part by thin sections made of heat conducting material, which are provided with cone or pyramid shaped indentations in order to prevent reflection of sun rays. A hot house effect is accomplished on the side turned towards the sun by use of a glass covering.

11981 Collector for solar energy. Courvoisier, J.C.; Meylan, J.L.C. (to Battelle Memorial Inst., Geneva (Switzerland)). German(FRG) Patent 2,607,740/A/. 9 Sep 1976. 37p. (In German).

The invention concerns an arrangement for the collection of solar energy which is designed to be installed in the roof of a dwelling house (possibly after construction), particularly one with a sloping roof covered with tiles. The arrangement of the invention can be installed advantageously in a window, which has been cut in part of a roof and is bounded by two roof beams and two adjacent rafters. The roof tiles here are replaced by element of hollow shape, whose outer surface is of the same size and shape as those of roof tiles, but which consist of material transparent to (solar) radiation. Underneath there is a surface which absorbs heat, of the size of the window cut-out, whose back is surrounded by an external heat-insulating housing. In this housing there is a spiral coil of pipe, in which water or air circulates, connected to the heating system of the dwelling house. In order to avoid overheating of the housing with strong solar radiation in the summer, flaps are provided which can be opened as required.

11982 Equipment for concentrating solar radiation. Szulmayer, W. (to Unisearch Ltd., Kensington (Australia)). German(FRG) Patent 2,605,127/A/. 2 Sep 1976. 17p. (In German).

The patent claim refers to a device by which solar radiation can be focussed in a linear target region. Stationary operation is possible without constant re-adjustment according to the position of the sun. The transparent refractor has a pattern of parallel, prismatic grooves diffracting the incident solar radiation. The light then falls on a trough-shaped reflector which concentrates it in the target region. Adjustment of the system according to the position of the sun is unnecessary due to the optical elements employed.

11983 Equipment for concentrating and collecting solar energy and an auxiliary method. Barr, I.R. (to AAI Corp., Baltimore, Md. (USA)). German(FRG) Patent 2,536,328/A/. 8 Jul 1976. 35p. (In German).

Equipment for concentrating and collecting solar energy is described. The half-cylindrical reflector focuses the solar radiation into one beam, i.e. where the proper absorber is. Various constructional designs are described. The collectors can be adjusted according to the position of the sun.

11984 Non-tracking solar concentrator with a high concentration ratio. Hinterberger, H. (to Energy Research and Development Administration). US Patent Application 701,480. 30 Jun 1976. 8p.

A nontracking solar concentrator with a high concentration ratio is provided. The concentrator includes a plurality of energy absorbers which communicate with a main header by which absorbed heat is removed. Undesired heat flow to those absorbers not being heated by radiant energy at a particular instant is impeded, improving the efficiency of the concentrator.

11985 Roof-skin or exterior-wall-heat-exchanger. German(FRG) Patent 2,458,303/A/. 16 Jun 1976. 7p. (In German).

The registration concerns a device for gaining usable heat from sun rays. Accordingly, the roof-skin is built up of a double layer, of which the outer layer is primarily penetrable for the sun rays; and the inner layer is primarily reflective. Between outer and inner layers pipes are found through which liquid flows or pipe systems which are arranged on the caustic reflective inner layer.

11986 Corrugated cover plate for flat plate collector. Hollands, K.G.T.; Sibbitt, B. (to Energy Research and Development Administration). US Patent Application 680,605. 26 Apr 1976. 6p.

A flat plate radiant energy collector is provided having a transparent cover. The cover has a V-corrugated shape which reduces the amount of energy reflected by the cover away from the flat plate absorber of the collector.

HEAT STORAGE

REFER ALSO TO CITATION(S) 11924, 11927, 11931, 11933, 11950, 12688

GEOTHERMAL ENERGY

11987 Energy R and D program statement. Task V: exploit renewable energy resources. Program 4: geothermal energy. Jessop, A.M. Ottawa; Energy, Mines, and Resources Canada (1975). 11p. Canada $1.20.

Recommendations are given for the establishment of new federally-supported research and development programs and the continuation of others. A four-phase program, including recognition, identification, evaluation, and development of resources, is discussed. (JGB)

RESOURCE STATUS AND ASSESSMENT

USA

11988 (COO/4362—1) **Low-temperature geothermal reservoir site evaulation. Quarterly progress report, May 1, 1977—July 31, 1977.** Hahman, W.R. Sr. (Arizona Univ., Tucson (USA)). Sep 1977. Contract EG-77-S-02-4362. 10p. Dep. NTIS, PC A02/MF A01.

ERDA, Division of Geothermal Energy, has charged the Bureau of Geology and Mineral Technology, Geological Survey Branch, University of Arizona, Tucson, with the responsibility of developing a cost-effective exploration program for low-to moderate-temperature geothermal energy. This program encompasses the exploration for geothermal resources in the State of Arizona. It is anticipated that several low-to moderate-temperature geothermal energy targets will be developed and brought on stream as demonstration projects. To facilitate this program and the demonstration projects, area and regional studies have been initiated using Landsat imagery, geophysics and geochemistry. Currently, three areas on the east side of the State have been designated for more detailed work: the St. Johns-Springerville area, the Clifton-Morenci-Safford area and the San Bernardino valley area. The detailed investigations in these areas have commenced. The reconnaissance exploration to locate other favorable areas is continuing. A comprehensive geothermal energy reference library is being compiled which is for use by industry and the public at the Geological Survey Branch offices in Tucson, Arizona.

11989 (NVO/0671—1) **Summary report of availability of geothermal data for potential direct heat application in Nevada.** Trexler, D.T. (Nevada Bureau of Mines and Geology, Reno (USA)). Sep 1977. Contract EY-76-S-08-0671. 12p. Dep. NTIS, PC A02/MF A01.

An assessment of available data on geothermal springs and wells was performed by first ascertaining which agencies both State and Federal maintain files which have water temperatures. The principal files are maintained by the Nevada Bureau of Mines and Geology, U.S. Geological Survey, and Water Resources Center-Desert Research Institute. The State Engineer's office maintains files of driller's logs. Requirements for completing driller's logs under subsection 5 states water temperature will be reported, if thermometer is unavailable an estimated temperature will be given as cold, warm or hot. The second phase of the assessment of available data to determine the quality of the data in each file was performed by inventory of files and by cross-correlating files by cursory examina-

tion. An estimate of the number of entries in the Nevada Bureau of Mines and Geology (NBMG) file with inferred temperatures that could be associated with confidence to replicate data was also made.

NON-USA

11990 (NP—22600) **Geothermal energy in France.** (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)). 1975. 24p. (In French). Dep. NTIS (US Sales Only), PC A02/MF A01.

A review is made of the extent of exploitation of geothermal resources in France as of 1975. The first section deals with the geothermal resource potential of the country, as determined from data drawn from exploratory and petroleum research drilling. In the regions of Paris and Alsace which are characterized by highly regular geological structure, geothermal reservoirs are successively described according to their stratigraphic order. The tectonic structure of Aquitaine and the South of France is complicated; consequently, it is less well understood. Isotherms and the areal extent of various aquiferous layers are mapped for each region. The Paris basin has several reservoirs suited for exploitation, whereas the thermal waters of Aquitaine are extensive but not conveniently recoverable. The second section reviews the economic and technical aspects of thermal water utilization. The drilling techniques used are similar to those employed in the petroleum industry. Reinjection of waste water generally allows more efficient operation. The duration of production can be estimated using graphic or numerical calculations. A general description is provided of the utilization of geothermal energy for space heating. Methods of optimizing this application are presented and discussed.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

11991 **Approximate calculations based on the simple one-phase model of a geothermal field.** Grant, M.A. (Dept. of Scientific and Industrial Research, Wellington, N. Z.). *N.Z. J. Sci.;* 20: No. 1, 19-25(Mar 1977).

The high viscosity contrast between hot and cold water makes possible a simple approximate solution for the one-phase model of a geothermal field. This provides a good fit to past behavior at Wairakei, but does not fit the Broadlands field.

USA

REFER ALSO TO CITATION(S) 12024

11992 (VPI-SU—5104-1) **Evaluation and targeting of geothermal energy resources in South Carolina. Progress report, May 1, 1976—January 31, 1977.** Glover, L. III; Krishna Sinha, A.; Costain, J.K. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Aug 1977. Contract EY-76-S-05-5104;EY-76-S-05-5103. 141p. Dep. NTIS, PC A07/MF A01.

Each of the three main sections of this report was abstracted and indexed separately for ERA/EDB. Also included are short sections entitled: acknowledgements; research objectives; introduction; personnel of program; and drilling program. (JGB)

11993 (VPI-SU—5104-1, pp A.1-A.75) **Geology (South Carolina).** Glover, L. III; Speer, J.A.; Farrar, S.S.; Becker, S.W. Aug 1977.

In Evaluation and targeting of geothermal energy resources in South Carolina.

Studies are reported under the following section headings: operations; Liberty Hill pluton; petrography of the Liberty Hill dri'l cores; magnetic modeling of the Liberty Hill and its contact aureole with comments on the mineralogy of magnetic phases; Winnsboro plutonic complex; opaque mineralogy; and molybdenum mineralization in the Liberty Hill and Winnsboro plutons. (48 references) (JGB)

11994 **Late mesozoic-quaternary plate tectonics and the Geysers-Clear Lake geothermal anomaly, Northern Coast Ranges, California (Abstract).** McLaughlin, J.R. (US Geological Survey, Menlo Park, CA). *Geol. Soc. Am., Abstr. Programs;* 9: No. 4, 464(Feb 1977).

The development of structures related to the Geysers-Clear Lake geothermal anomaly can be explained in terms of relative motions of the North American and Pacific plates. Hypothetically, plate convergence during Late Jurassic to mid-Tertiary time produced a west-stepping subduction zone that thrust successively younger plates of sediments and volcanic rocks of the Franciscan assemblage eastward beneath oceanic crust and depositionally overlying sediments of the Great Valley sequence. East of this subduction zone, elements of previously subducted Franciscan plates were uplifted and faulted into the basal part of the ophiolite in response to regional compression. Some of the faults bounding the uplifted wedges died out upward into northwest-trending folds in the overlying ophiolite sheet, and others formed imbricate thrusts along which wedges of Franciscan rocks pierced the ophiolite. Many of these thrusts were later reactivated as strike-slip faults as motion between the Pacific and North American plates changed. Postulated rates of right-lateral motion between the Pacific and North American plates for the past 5 to 6 million years indicate that subduction and associated processes leading to partial melting deep in the subduction zone terminated in the Clear Lake region about 3 million years ago, with passage of the Mendocino triple junction. Following local termination of subduction, about 0.5 million years elapsed before eruption of the first Clear Lake volcanic rocks, during which time magma moved upward to mid-crustal levels, and extensional and strike-slipfaulting established conduits for venting of magma. This tectonic model implies that any significant new sources of geothermal energy in the Coast Ranges are most likely to be found north and northwest of the Clear Lake region, where subduction has recently been or is now active.

11995 **Seismic velocity anomalies in the vicinity of Mt. Baker, Washington (Abstract.** Rohay, A.C.; Malone, S.D. (Univ. of Washington, Seattle). *Geol. Soc. Am., Abstr. Programs;* 9: No. 4, 490(Feb 1977).

A sudden increase in fumarolic activity at Sherman Crater on Mt. Baker occurred in March 1975. Observations of gravity and tilt suggest that deep seated changes in the hydrothermal plumbing system are responsible for this increase. To investigate the velocity structure in the Mt. Baker area, a portable seismic network was installed in addition to five existing permanent stations. Explosions from an active quarry on the opposite side of Mt. Baker were recorded at some two dozen locations, for the purpose of studying in detail paths through the mountain. Delays of up to 0.10 sec +- 0.05 sec were observed for rays passing within a few km of the mountain's center. These explosions as well as our own blasts are used to define the contact between the Mt. Baker andesites (V/sub p/ = 3.0 km/s), and the major upper crustal refractor (V/sub p/ = 6.0 km/s). Similarly, teleseisms and regional earthquakes are used to study station delays and deeper structures.

11996 **Geopressured—geothermal energy from the Frio Formation, Texas Gulf Coast: review of ideal and actual prospects (Abstract).** Bebout, D.G.; Loucks, R.G. (Univ. of Texas, Austin). *Geol. Soc. Am., Abstr. Programs;* 9: No. 1, 4(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

The Bureau of Economic Geology, The University of Texas at Austin, has been searching for geopressured geothermal prospects in the downdip portion of several offlapping, basin-ward-thickening wedges of Tertiary sand and shale along the Texas Gulf Coast. The ideal prospect model is a reservoir with a volume of at least three cubic miles (which translates into a cumulative sand thickness of greater than 300 feet and areal extent of 50 square miles), greater than 300°F subsurface fluid temperature, permeability greater than 20 millidarcies, and water saturated with methane. Several prospective geothermal fairways have been identified in the Frio Formation of Kenedy, Nueces, Matagorda, and Brazoria Counties. However, only the prospect in the Brazoria Fairway (the Austin Bayou Prospect) meets all of the requirements of the ideal geopressured geothermal prospect. The Austin Bayou Prospect contains up to 1,200 feet of sand with hundreds of millidarcies permeability below 13,500 feet in depth. The optimal sand thickness extends over an area of at least 60 square miles; subsurface temperatures are as high as 330°F. Enormous reservoirs extending over hundreds of square miles with hundreds of millidarcies permeability predicted by previous workers have not been found in the Frio. However, initial studies indicate that the smaller reservoirs which are being delineated are capable of producing significant quantities of thermal energy and methane.

11997 **Geologic setting of hot springs, Trans—Pecos, Texas and adjacent Mexico (Abstract).** Henry, C.D. (Univ. of Texas, Austin). *Geol. Soc. Am., Abstr. Programs;* 9: No. 1, 25(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

Hot springs in Trans-Pecos Texas (up to 47°C) and adjacent Mexico (up to 80°C) are found in a zone along the Rio Grande between the Quitman Mountains and Big Bend National Park. Two distinct types of springs occur: fault controlled and stratigraphically-controlled springs. Most hot springs are on or immediately basinward of major northwest-trending, basin margin normal faults. Other springs occur either along similar normal faults more basinward or those cutting middle Tertiary or older bedrock. Springs of both types are located in topographically low areas. It is probable that thermal waters are present in other localities but discharge into highly permeable bolson sediments without reaching the land surface as springs. Thermal waters are in contact with limestone, siliceous volcanic rocks, bolson deposits composed of volcanic rocks and limestones, and evaporites. Chemical equilibrium of the thermal waters should be controlled by these lithologies. Travertine deposits associated with many springs imply low reservoir temperatures or near-surface reequilibration with limestone. Precipitation of carbon-

ates and flow of thermal waters through siliceous volcanic rocks and evaporites limit the use of silica or Na-K-Ca geothermometers. Recent igneous activity, though common in southern New Mexico, has not been documented in Trans-Pecos Texas and is an unlikely heat source for the thermal waters. Groundwater may be heated by deep circulation along faults in an area of high heat flow due to a thinned crust from Late Cenozoic extension.

11998 Geothermal exploration of Presidio County, Trans—Pecos, Texas (Abstract). Kopp, R.A. (Univ. of Texas, El Paso). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 1, 31-32(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

Over 250 water samples from springs and wells have been collected in Presidio County. Three broad areas within the county contain a total of 13 wells or springs having surface temperatures from 30 to 72° C; these areas include: (1) Candelaria, (2) south of Marfa, and (3) near Ruidosa. Based on the silica geothermometer a total of 138 samples show subsurface reservoir temperatures equal to or greater than 100° C. The hottest areas occur north and south of Candelaria and south of Marfa where subsurface temperatures are estimated to exist from 125 to 177° C. Current studies are aimed at defining the extent of the hot water areas, determine the relationship of the hot waters to the geology of the area, and analyze the chemistry of the waters.

11999 Depressions surrounding volcanic fields: a reflection of underlying batholiths. Heiken, G. (Los Alamos Scientific Lab., NM). *Geology;* **4**: 568-572(Sep 1976).

The eastern Klamath Mountains of northern California are cut sharply by an arcuate scarp that forms the west wall of a depression containing Pliocene to Holocene lavas. This depression may have formed by collapse along hidden concentric fractures over a batholith and, if so, reflects the shape and areal extent of the body. Large depressions enclosing other volcanic fields are evident on small-scale satellite imagery. If such depressions overlie still hot or even molten batholithic bodies, analysis of satellite imagery might delineate the areal extent of associated geothermal resources.

NON-USA

REFER ALSO TO CITATION(S) 12014, 12025, 12050, 12058, 12059

12000 (NP—22488) Distribution map of hot springs in Japan. Sumi, K. (Geological Survey of Japan, Kawasaki, Kanagawa). 1975. 16p. (In Japanese). TIC.

This map (scale 1:2,000,000) provides the distribution and locations of hot springs in Japan. A hot spring is defined as hot water, mineral water, vapor or other gases (excluding natural gases containing hydrocarbons as the major component) issuing from underground at a temperature of 25°C or higher and/or containing substances listed on the map in specific concentrations. Springs are classified according to their chemical composition. Each class of spring is assigned one of five different symbols (per class) according to its temperature. Where appropriate, the geologic age of the spring location is identified. A comprehensive place name index is provided in both Japanese and English transliteration. The map is also isothermically graduated in HFU and references are given for descriptive textual materials that may be used as supplements.

12001 Physical characteristics and conditions of coming out of the hyperthermal springs in Chaudes—Aigues. Bertrand, G.; Gilbert, J.P.; Laugier, R. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **285**: No. 5, 501-504(19 Sep 1977). (In French).

The determination of temperature, pH, rH, and resistivity were performed on waters from 26 springs of Chaudes-Aigues. Dynamics between the upward hydrothermal veins and climatology, morphology and tectonics were studied. The model constructed suggests a possible means of improving the protection of the perimeter of emergence.

12002 Estimate of the lifetime of the Wairakei geothermal field. Robinson, J.L. (Dept. of Scientific and Industrial Research, Wellington, N.Z.). *N.Z. J. Sci.;* **20**: No. 1, 27-29(Mar 1977).

A simple one-phase model of the Wairakei geothermal field is used to obtain an estimate of the lifetime of the field. The change of radius due to an influx of cold groundwater is calculated, and the associated change with time in the exploited depth of the field reduces the resource volume and the lifetime by about 25% from constant depth estimates.

12003 Distribution map of Hot Springs of Japan in scale 1:10,000,000. Sumi, K. *Chishitsu Chosasho Geppo;* **28**: No. 2, 81-93(Feb 1977). (In Japanese).

The 929 hot springs plotted are the springs having a discharge higher than 100 liters per minute. Open circle, semi-solid circle and solid circle represent the hot springs of equal to or higher than 42°C, equal to or higher than 25°C and lower than 25°C in water temperatures, respectively. Full line is the boundary line between volcanic and/or folded zone (continental side of Japanese islands and the Izu islands area) and non-volcanic and/or unfolded zone (oceanic side) in miocene age (after Isomi, 1968).

12004 Mechanisms of rifting, heat flow, and mantle convection (Abstract). Bridwell, J. (Los Alamos Scientific Lab., NM). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 1, 8-9(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

Integrated gravity, thermal, and tectonic models suggest thinning of the lithosphere by buoyant intrusion of mantle beneath the northern Rio Grande Rift. The rift is a series of elogate, en echelon, rift valleys bounded by normal faults which downdrop basins between regionally up-lifted shoulders. Geophysical signatures consisting of high heat flow (>2.5 HFU), volcanism (>10 my), and a moderate level of seismicity (M approximately 5.5/100 yrs) are asymmetric to the structural rift, occurring on its west flank. Gravity models indicate lithospheric thinning and presence of lateral inhomogeneities in the crust. Thermal models, consistent with meager petrologic data, indicate increased geothermal gradients, requirements for crustal sources of abnormally high heat content, and a relatively shallow partial melt zone. Convective models create dynamic upwelling, predict high surface heat flow over the upwelling, and increase surface topography above the thermal plume. The conducting lithosphere, in moving over upwelling arms of the convection cell, destroys its symmetry, both shortening the eastern limb and elongating the limb under the westward moving plate. Asymmetric convective transport of heat westward provides sustained melt conditions for evolution of basalt magma. Plume flow and isolated buoyant magma bodies provide uplift of the plate forming inhomogeneities in the crust, surface volcanics west of the rift, and volcanic piles along major faults of the rift's west flank. Rift mechanics consist of convective heat transport which provides energy through gravitational instability, thins the lithosphere, uplifts regionally elevated shoulders, creates normal faulting through extension of the elastic crust, extrudes voluminous basalts through major crustal fault zones, and generates high surface heat flow.

12005 Continuous observation of temperatures and water-levels in Hakone Volcano, 1974. Hirota, S.; Odaka, S. (Hot Spring Research Inst. of Kanagawa Prefecture, Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **6**: No. 2, 79-87(1975). (In Japanese).

A description is given of the continuous observation of temperatures at six stations, four of hot spring, two of thermal waters discharged from deep wells and water-levels in deep bore holes at five stations in Hakone Volcano, 1974. The temperature anomaly of thermal waters encountered in the eastern flank of Kamiyama remains after more than 7 years. The relation between temperature and rainfall is distinct in natural hot springs. After the Izu-Hanto-Oki earthquake on May 9, 1974, which occurred off the Izu Peninsula, the water level of the Motohakone deep hole was lowered by 18cm, which gives good correlation to the crustal deformation of the Izu Peninsula after the earthquake.

12006 Geology of hydrothermal system of the Yumoto-Tonosawa Area, the eastern foot of Hakone volcano. Odaka, S.; Oki, Y.; Hirota, S. (Hot Spring Research Inst., Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **3**: No. 3, 95-108(1972). (In Japanese).

There are 68 drilled wells and 3 hot springs in the Yumoto-Tonosawa area, mostly being used for Japanese baths. The total discharge of thermal water and of thermal energy amounts to 5,608 l/min and 2.1 x 10^8 cal/min. The geological succession of the mapped area is discussed. The Hakone volcano consists of central cones, lacking in mapped area; young somma lavas; and old somma lavas. The basement rocks of the Hakone volcano are of the Sukumogawa andesite group and Hayakawa tuff breccias (upper Miocene) and Yugashima formation (lower Miocene). Although the major resource of thermal energy is obviously the volcanic activity of Hakone volcano, the thermal waters are reserved in the fracture system of basement rocks of the volcano. Volcanic pile covering the basement rocks shows high permeability and provides a good reservoir system for cold groundwater. Subsurface temperature maps, the piezometric surface of thermal water, and distribution of high temperature water characterized by considerable amount of NaCl strongly suggest the upflow of hot water through a fractured zone. In shallow places where the basement rocks are considerably shattered, the hot water mixes with cold groundwater and spreads over the area as thermal water.

12007 Hydrological mechanism of the thermal springs at Plombieres. Maubeuge, P.L. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **282**: No. 17, 1589-1592(3 May 1969). (In French).

Evidence is reported of a fault lowering the triasic inclinations near the granite at Plombieres. A basement anomaly has always been considered as a thermal fault to the northeast of the valley with no thermal emergence up to the present. It now appears that there is a tectonic ditch where two faults, confluent at depth, constitute a thermosiphon. The discovered fault constitutes the feed branch of the thermosiphon and the source of the hottest springs on the

thermal fault. With the presence of a thermosiphon the waters can be pumped without risk of failing. (JSR)

12008 Anomalous temperature encountered in the Gora hydrothermal system of Hakone Volcano and it hydrological explanation. Oki, Y.; Ogino, K.; Hirano, T.; Hirota, S.; Ohguchi, T.; Moriya, M. (Hot Spring Research Inst. of Kanagawa Prefecture, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* No. 6, 1-20(Mar 1968). (In Japanese).

The temperature of the thermal water discharged from some drill holes in Gora and the surrounding area increased 20°C on 23rd of May, 1967, and continued at that temperature for five months. Then the temperature dropped suddenly to its usual range and has remained at that level. It is suggested that the abnormal temperature is closely related to the increased earthquake activity of Hakone Volcano in June and July, 1965. Groundwater that infiltrates the western side of the caldera seems to be flowing eastward passing through the bottom of central cones, where violent steam is coming up through volcanic vents. Two streams of high temperature water originate in the depths of Soun-jigoku, an active solfataric area, and run through the permeable zone developed in the basal part of central cones. After a year of earthquake activity, this water arrived in the Gora area, as evidenced by the abnormal temperature of the thermal water.

12009 Geological investigation of a drill hole at Moto—Hakone and its relationship to the hydrothermal system of Hakone Volcano. Oki, Y.; Ogino, K.; Ohguchi, T.; Hirota, S.; Hirano, T.; Moriya, M. (Hot Spring Research Inst. of Kanagawa Prefecture, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* No. 6, 21-34(Mar 1968). (In Japanese).

A 197m drill hole was newly opened at Moto-Hakone, on the southern side of the caldera. A three-stage lithological succession is described. The temperature of the bottom of the hole was 15.65°C. The thermal gradient was very small and found to be only 3.0°C/100m below the depth of 170m. Four aquifers having an average permeability of 3.2×10^{-2} cm/sec were found in the Moto-Hakone volcanic breccia and in the basal part of the Komagatake lava flow. A considerable amount of ground water may be flowing from the western and southern side of the caldera, and thus depresses the thermal gradient in the western side of the central cones. A significant volume of thermal water, supplied in this way on the western side of the caldera, appears as thermal springs in the eastern side of the caldera.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 11988, 11992, 11995, 12005, 12008, 12009, 13174, 13176

12010 (NP—22637) **Heat flow measurements in the Federal Republic of Germany.** Bram, K. (Niedersaechsisches Landesamt fuer Bodenforschung, Hannover (Germany, F.R.)). 20 Dec 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The general heat flow distribution in the Federal Republic of Germany was mapped on the basis of 65 corrected heat flow values. As a result, the heat flow was found to be directly related to the gross geological structure and regional geological units, especially the sedimentary basins in both northern and southern Germany. An anomalous zone appears to exist in the area between the Rheingraben (SW) and the Braunschweig-Altmark region (NE). This follows the general trend of Stille's Mittelmeer-Mjosen' zone. Twenty-nine references are given.

12011 (VPI-SU—5104-1, pp B.1-B.40) **Geochemistry (South Carolina).** Sinha, A.K.; Merz, B.A. Aug 1977.

In Evaluation and targeting of geothermal energy resources in South Carolina.

As an integral part of the targeting procedures for locating areas of high heat production and high subsurface temperatures, 60 chemical analyses of whole rock samples were completed. Both Winnsboro and Liberty Hill plutons were analyzed for the oxides of Si, Al, Ca, Mg, K, Fe, Na, Mn, Ti, and P. Results are tabulated. (JGB)

12012 (VPI-SU—5104-1, pp C.1-C.13) **Geophysics.** Costain, J.K.; Rohrer, C.S.; Dunbar, J.A.; Perry, L.D. Aug 1977.

In Evaluation and targeting of geothermal energy resources in South Carolina.

As part of a planned intercalibration between several gamma-ray spectroscopy laboratories in the United States, 20 samples from the Liberty Hill-Kershaw and Winnsboro plutons, SC were analyzed. The results of uranium, thorium, and potassium determinations for these samples are tabulated along with computed values of heat generation. Temperature and geothermal gradient profiles in the Liberty Hill-Kershaw pluton are presented. (JGB)

12013 Concentrated geothermal observations at Kusatsu Sessyogawara Geothermal Field, Gumma, Japan. Yuhara, K.; Sekioka, M.; Nishimura, K.; Kawamura, M.; Sahashi, K.; Ehara, S. *Chishitsu Chosasho Geppo;* **28**: No. 6, 9-30(Jun 1977). (In Japanese).

At the Kusatsu Sessyogawara Geothermal Field several kinds of geothermal measurements were carried out concentratedly on June 3 to 8 and July 14, 1974. The measurements included the airborne infrared line-scanning, the land-based infrared thermal image scanning, the surface temperature survey with infrared radiation thermometer, the shallow ground temperature survey, the measurement of ground-surface thermal conductivity, the geothermal calorimetry in steaming ground, the measurement with heat-flow meter and the micrometeorological observations at the surface layer. The purpose of the observations is to make clear the relations among the results of these measurements, since almost all of them are imperfect in both principle and operation and include some differences. In the light of the observations, a suitable system for geothermal field measurements must be developed by combining some of above methods.

12014 Gravity and heat discharge survey at northern Kurikoma Geothermal Area, Northeast, Japan. Suda, Y.; Baba, K.; Takaki, S.I. *Chishitsu Chosasho Geppo;* **28**: No. 3, 1-34(Mar 1977). (In Japanese).

A gravimetric survey was applied to the underground structure at Northern Kurikoma area, Northeast Japan. Main Bouguer anomalies exist generally along the direction from northwest to southeast. The general trend of anomalies coincides well with that of geologic structures in the so-called green-tuff region of Northeast Japan. The big fault-structures are assumed to exist both at the northeastern margin and the southwestern one in the surveyed area judging from the pattern of the obtained Bouguer anomaly map. The central part of the surveyed area shows a wide low anomaly, in which some areas of small high anomaly exist. This is concluded to show the existence of some of local area in which the depth to the basement-rock is comparatively shallow. Most of the surface geothermal manifestations are on those high anomalies especially at the surrounding parts. It is concluded that the detailed exploration for geothermal reservoirs should be carried out in this area. In order to measure the magnitude of surface geothermal activity in the surveyed area, natural heat discharge measurement was carried out. The total heat discharge was about 18,000 kcal/sec. This heat discharge-rate corresponds to VI of the heat index defined by Fukutomi.

12015 Gravimetric survey at the southern part of Izu, preliminary survey for geothermal exploration. Ogawa, K. *Chishitsu Chosasho Geppo;* **28**: No. 3, 35-44(Mar 1977). (In Japanese).

A gravimetric survey was carried out at the southern Izu area where many hot springs exist. The area covered by this survey was about 410 square-kilometers and the observed points were 674. A Bouguer anomaly map was completed by using usual method. Many local anomalies were obtained in the map. It can be pointed out that the areas where altered rocks by mineralization exist or the outcrop of Yugashima formation is on and near the surface show generally local positive anomalies. Such a correlation is reasonable because the mineralization from the deep places can be thought to have given the increase of density in the altered rocks and Yugashima formation has high density generally judging from the density measurement of rock-specimens. There are four main hot-spring areas in the surveyed area. Two of them, Kawazu and Shimogamo, are respectively situated at local negative anomalies. On the other hand a group of hot springs near and at Rendaiji is situated at a local positive anomaly. The hot springs of west coast exist along the zone of high gravity gradient in the horizontal direction which is clearly shown in the Bouguer anomaly map. These facts are useful when the detailed survey around a known hot spring area is developed. In order to know the approximate depth to the surface of basement rock (Lower part of Yugashima formation), three profiles were selected and the result is shown.

12016 Determining the dimensions of a geothermal reservoir on Kilauea Volcano, Hawaii, by seismic data (Abstract). Furumoto, A.S.; Suyenaga, W.; Norris, R. (Univ. of Hawaii, Honolulu). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 4, 421(Feb 1977).

Epicenters of microearthquakes monitored during the exploration phase of a geothermal project were found to cluster around an area which later turned out to contain a commercial quality geothermal reservoir. From the distribution of epicenters, the reservoir is estimated to cover an elliptical area 2 km by 3 km. Microseisma in the 4 hz band showed a 9 db high around the area. If the reservoir is assumed to be in the form of a closed pipe resonator, its length would be in the order of a kilometer or two, agreeing with the microearthquake data. Seismic data have shown to be more useful than electrical methods in outlining the boundary of this particular reservoir. The energy content of this reservoir is estimated to be about 6×10^4 megawatt years.

12017 Geysers geothermal reservoir properties from seismological data (Abstract). Majer, E.; McEvilly, T.V. (Univ. of California, Berkeley). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 4, 459(Feb 1977).

An east-west profile extending through the center of the steam production zone at the Geysers Geothermal Field recorded data from two USGS refraction line explosions 8 and 18 km west of the field, plus seventy microearthquakes of magnitude -1.0 to 1.0 with depths of 1 to 5 km, during a five-day field study in September 1976. V/sub p//V/sub s/ data from Wadati diagrams indicate lower Poisson's ratios in the field than in surrounding areas. P-wave fault plane solutions show a dominant northeast-southwest compressive stress, consistent with regional coast range tectonics. A b value of 0.8 for microearthquakes in the field is not abnormal. P-wave velocity through the production zone, however, is higher than in the surrounding areas. Seismograms from the two explosions and some earthquakes outside the field were examined for changes in frequency content as a function of position across the field with signs of higher attenuation through the field. Microearthquakes within the field were examined for evidence of spatial source variations in radiated P- and S-waves.

12018 Shallow temperature gradient study at Clear Lake, California (Abstract). Martin, R.C. (California State Lands Division, Long Beach). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 4, 461(Feb 1977).

A one-meter temperature gradient survey method was tested at Clear Lake, California, as a rapid, first-step method to evaluate the geothermal potential of submerged lands in California. Four geothermal anomalies were detected in shallow lake bottom sediments. These are near known thermal springs or volcanic features only 0.1 to 0.4 million years old. The probe consists of a one-meter fiberglass tube partially encased in steel with six precision calibrated thermistors. Two circuit configurations were employed. The most useful data to minimize effects of solar heating were found to be bottom temperatures (80 cm depth) used in conjunction with a short 20-cm gradient measured at the lower end of the probe.

12019 Geothermal heat flux transducers. Poppendiek, H.F.; Meckel, P.T. (to Thermonetics Corp.). US Patent 4,003,250. 18 Jan 1977. Filed date 8 Sep 1975. 10p.

A geothermal heat flux transducer includes a plurality of insulating slats on which constantan wire is wound and each half turn is coated with a silver layer to produce a hot junction and a cold junction per turn of wire. The slat with wire thus coated is assembled with insulating material between adjacent slats such that silver coatings on adjacent slats face each other and also uncoated wire half turns on adjacent slats face each other. This allows a multiplicity of thermal junctions thus formed to be assembled in a small package which may be suspended in earth bore holes in mine shafts or otherwise below or above ground for measurement of heat flow emanating from sources far below the earth's surface. Variable heat flow occasioned by diurnal and/or seasonal variations are accounted for in ascertainment of that steady heat flux flowing from geothermal sources alone. The transducer is of special dimensional proportions with parts specially related both structurally and thermally.

12020 Review of the significance of geothermal and gravity studies in the southern Rio Grande rift (Abstract). Decker, E.R.; Smithson, S.B. (Univ. of Wyoming, Laramie). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 1, 15(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

Recent studies suggest that the Rio Grande rift in southern New Mexico is a zone of very high reduced flux (greater than or equal to 1.8HFU), which contrasts strongly with lower values (1.2-1.5HFU) in adjacent portions of the Basin and Range high heat flow province. A +30 mgal Bouguer gravity anomaly also occurs in this portion of the rift, and the Bouguer gravity relief to the east and west is small. The gravity high can be explained by an upwarping of high temperature and low density upper mantle and/or shallow sills and dikes of mafic rocks in the crust in the rift. Interpreted in terms of steady heat sources, the reduced heat flow anomaly implies massive amounts of melting in the lower crust. Transient heat flow interpretations imply less crustal anatexis than do steady-state models of the thermal anomaly. The transient models also refine interpretations from gravity by requiring that the combined heat flow and gravity highs be explained by high temperature and low density masses in the upper mantle. Related discussion focuses on the relations between geophysical interpretations and the late Cenozoic volcanism and regional geology in the rift.

GEOCHEMICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 11992, 11998

12021 Radiogenic and stable isotope studies of hot-spring deposits in Yellowstone National Park and their genetic implications. Leeman, W.P.; Doe, B.R.; Whelan, J. (Denver Federal Center, CO). *Geochem. J. (Nagoya);* **11**: No. 2, 65-74(Jun 1977).

Samples of travertine and siliceous sinter from hot-spring deposits in Yellowstone National Park of northwestern Wyoming have been analyzed for light stable (carbon and oxygen) and radiogenic (lead and strontium) isotopes. The Hillside Springs travertine contains significantly higher $\delta^{13}C$ than the previously studied Mammoth travertine. Although this relation could indicate a component of magmatic carbon, more likely it reflects a higher temperature of precipitation for Hillside Spring travertine. Our data on Mammoth travertine shows it to have been precipitated substantially below the orifice temperature. The oxygen isotope data on the newly analyzed deposits confirm the previous studies that found the hot-spring waters to be dominated by meteoric water. The lead isotope data show that there is a sedimentary component of lead in all the hot-spring deposits analyzed, including those inside the caldera limits. Either long lateral migration of waters are involved in the recharge of the springs or there must be sediments buried at some unknown depth beneath the volcanic rocks inside the caldera because no sediments are known at the surface. The high rainfall inside the limits of the caldera would favor sediments buried at depth.

12022 Formation and stability of polysulphide ions in thermal water from Enghien (France). Boulegue, J.; Gourmelon, C. *C. R. Hebd. Seances Acad. Sci., Ser. D;* **284**: No. 7, 507-510(14 Feb 1977). (In French).

The thermal water from Enghien is characterized by simultaneous presence of sulfide, polysulfides, sulfur and thiosulfate species. Owing to the presence of colloidal sulfur, polysulfide ions represent half the reduced sulfur species within the water. The stability of this water is very good. It can be kept unchanged from the chemical point of view for a long period, and oxidation by contact with air is slow.

12023 Geochemical methods for geothermal water samples, Trans—Pecos, Texas (Abstract). Curtis, R.E. (Univ. of Texas, El Paso). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 1, 13-14(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

Over 700 water samples from hot to cold springs and wells have been collected from a six county area of approximately 22,000 square miles in west Texas. Geochemical studies of the waters are in progress to locate possible hot water geothermal sites in the region. For each water sample information concerning depth of the well, rate of discharge, color and turbidity, and geologic occurrences of the water were recorded. Samples have been analysed for sodium, potassium, calcium, lithium, and silicon by atomic absorption and fluoride and chloride by specific ion electrodes. The analyses show the following concentrations in ppM: sodium, 2-2,400; potassium, 0.1-215; calcium, 0.4-693; lithium, 0.0-3.2; silicon, 4-82; fluoride, 0.2-19; and chloride, 2.1-3,400. A Kernco DS meter was employed to determine dissolved solids content which range from 200 to 11,000 ppM. In addition, the samples are currently being analyzed for uranium, magnesium, beryllium, boron, mercury, arsenic, and strontium. The Na-Ca-K and SiO_2 geothermometers have been calculated from above analyses and used to indicate the most favorable geothermal sites.

12024 Geothermal exploration program, Trans—Pecos, Texas (Abstract). Hoffer, J.M. (Univ. of Texas, El Paso). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 1, 26(Jan 1977).

From 11. annual meeting of the Geological Society of America, South-Central Section; El Paso, TX, USA (17 Mar 1977).

A program to evaluate the geothermal potential of a six county area in West Texas was recently initiated. The region of study includes approximately 22,000 square miles in El Paso, Culberson, Hudspeth, Jeff Davis, Presidio and Brewster counties. The first year program includes geological and geochemical studies in an attempt to locate and define the occurrence of natural hot waters. To date over 700 water samples have been collected. Forty-five spring or well samples show surface temperatures ranging from 30 to 72°C. These warm to hot water occurrences are found in twelve different areas of the region. Based on the silica geothermometer approximately 250 springs and wells have reservoir temperatures of at least 100° C. In addition to silica, each water sample has been analysed for sodium, potassium, calcium, lithium, fluoride, choride, magnesium plus numerous metals. Geological studies include detailed surface mapping in the immediate area of selected hot water localities plus the construction of a regional geologic map showing the locations of major structures and igneous rock occurrences.

12025 Geology of hydrothermal system of the Yumoto-Tonosawa Area, the eastern foot of Hakone volcano. Hirano, T.; Oki, Y.; Awaya, T. (Hot Spring Research Inst., Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **3**: No. 3, 109-130(1972). (In Japanese).

Four zones have been recognized in the distribution of thermal waters of Hakone. The thermal waters of the Yumoto-Tonosawa Spa issuing from the basement rocks can be classified as zone

4b (sodium chloride--bicarbonate—sulfate water nicknamed as mixed type). Thermal waters of the area are further subdivided into two groups. The one is zone 4b-H characterized by high temperature and considerable amount of sodium chloride together with subordinate amount of sulfate and bicarbonate. The other is zone 4b-C, characterized by moderate temperature and a considerable amount of calcium sulfate and sodium chloride. Thermal waters discharged from drill-wells along the Sukumo River, usually low in temperature and in dissolved materials, are formed by the mixing of 4b-H water with the surface water and can be classified as 4b-L group. Thermal waters discharged from wells along the Hayakawa River are also explained by the mixing of the salt-rich waters of zone 4b-C with the surface water and can be classified as 4b-D group. The hydrothermal system of the Yumoto-Tonosawa area can be explained on the basis of the zonal mapping of thermal waters.

EXPLORATORY DRILLING AND WELL LOGGING

12026 Spectral gamma logging in crystalline basement rocks. West, F.G.; Laughlin, A.W. (Los Alamos Scientific Lab., NM). *Geology;* **4**: 617-618(Oct 1976).

Spectral gamma logging in the crystalline basement rocks of two deep holes of the Los Alamos Scientific Laboratory's Dry Hot Rock Geothermal Project indicates that this type of log is useful for determining rock types, detecting fracture zones, and examining mobility of the heat-producing elements U, Th, and K.

ECONOMIC AND FINANCIAL ASPECTS

12027 Costs of geothermal energy development. Final report, January 1977. Larson, T. (Univ. of California, Riverside). pp 314-336 of In Geothermal world directory. Reseda, CA; Geothermal World Publications (1977).

Risks and reward associated with geothermal development are summarized. Various methods for evaluating geothermal energy as an investment are discussed; factors affecting the investors' risk perceptions are described. Factors influencing the different view of risk taken by the public utilities, in contrast to that of private industry, are discussed. (JGB)

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

12028 (ORNL/TM—6057) **Potential impacts on aquatic ecosystems from the release of trace elements in geothermal fluids. Environmental Sciences Division publication No. 1097.** Cushman, R.M.; Hildebrand, S.G.; Brocksen, R.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

Analyses of 14 trace elements found in hydrothermal fluids from various geothermal reservoirs in the western United States are presented. The concentrations of these elements, which include As, B, Ba, Br, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Rb, Ti and Zn, vary over orders of magnitude between reservoirs. Potential impacts are conservatively assessed on the basis of toxicity to freshwater biota, and bioaccumulation in food fish to the point where consumption might be hazardous to human health. Trace element concentrations generally range from benign levels to levels which might prove toxic to freshwater biota and contaminate food fisheries. The need for site-specific analyses and careful handling of geothermal fluids in order to minimize potential impacts is stressed.

12029 Geothermal development and the Salton Sea. Goldsmith, M. (Calif Inst of Technol, Pasadena). *Energy (Oxford);* **1**: No. 4, 367-373(Dec 1976).

One of the limiting factors on energy development in the arid American West is the availability of water. Even geothermal development must take into account the hydrologic cycle of the surrounding area. In the Imperial Valley, the bloodstream of the economic body is water and, owing to the nature of the region and its water source, the mineralized Colorado River, the disposal of waste water is of major importance. The Salton Sea is presently the sump for agricultural drainage in that area. Geothermal development in the Valley will involve the flow to the surface of large quantities of highly mineralized water. After extraction of heat, the water must be safely disposed of. Moreover, many geothermal power generation methods would require cooling water supplies, and other methods may require water for reservoir injection. Geothermal development may well impact the hydrologic cycle. Conversely, the requirements of the local hydrologic cycle may well impact the nature of geothermal development. The purpose of this study is to examine the relationship of the Salton Sea, a key element of the Imperial Valley water system, to potential geothermal development. 12 refs.

12030 Volcanic hazards: extent and severity of potential tephra hazard interpreted from layer Yn from Mount St. Helens, Washington (Abstract). Mullineaux, D.R. (US Geological Survey, Denver). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 4, 472(Feb 1977).

Volcanoes in the conterminous United States erupt infrequently but represent a significant potential hazard. Tephra eruptions can affect broader areas and reach population centers at greater distances from a volcano than any other kind of volcanic event. Lava flows, pyroclastic flows, mudflows, and floods can be more hazardous, but they seldom extend beyond a volcano except along valleys. Severity of risk from tephra depends in part on rate of fall and grain size, but mainly on thickness. Rates of fall from future eruptions in the Cascade Range must be estimated from historic eruptions elsewhere; potential grain sizes and thicknesses can be judged from past tephra eruptions of the Cascade volcanoes themselves. Pumice layer Yn, erupted by Mount St. Helens about BC 2000, exemplifies an extensive and thick tephra resulting from a single eruptive pulse of a Cascade volcano; in thickness and volume it resembles tephra of the type Plinian eruption of Vesuvius in Italy in 79 AD. Layer Yn trends NNE from Mount St. Helens in a long narrow lobe that is much thicker at any given distance than if the layer had formed a wide lobe. On broad ridges where it should be nearly unaffected by thickening or erosion, its present (compacted) thickness is as much as 70 cm at about 50 km from the volcano, 20 cm at 100 km, and 5 cm at about 280 km. Future eruptions like that of layer Yn could produce similar thicknesses in any easterly direction between about NNE and SSE downwind from Mount St. Helens or any other explosive Cascade volcano. Weaker winds toward the west indicate that potential thicknesses are less in westerly directions.

12031 Water pollution of thermal waters wasted from baths, Hakone. *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **6**: No. 2, 87-116(1975). (In Japanese).

Public sewage systems are now planned in Hakone to provide a sanitary environment in the Hakone National Park. Thermal waters used for baths in Hakone amount to about 27,500 m^3/day, which is 5.4% of the total discharge of Hayakawa, the major drainage of Hakone calders. Cold waters used for temperature control of the thermal baths amount to 16,000 m^3/day, which is 3.2% of the Hayakawa discharge. Dissolved materials in stream water are largely affected by the wastes of thermal baths. Thirty-seven samples, including wastes of hotels, thermal waters from baths and river waters, were analyzed. The highest BOD values in the wastes of thermal waters is 4.7 ppM showing fairly small pollution when compared with that of drainage from private sanitation facilities. BOD in wastes of thermal waters is mostly dependent on soap consumption and the number of people taking baths. Drains from private sanitation facilities are the major factor causing pollution of the river. All wastes of thermal waters from baths in the present drain systems should be treated in public sewage systems.

12032 Hydrogen sulfide-toxic death at Yunohana Spa, Hakone volcano. Iwata, Y. (Odawara Health Center, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **3**: No. 3, 143-150(1972). (In Japanese).

Two boys and a girl in taking bath at Yunohana Spa suffered death by hydrogen sulfide toxicosis on 5th of November 1951 and on 27th of March 1952 successively. The two accidents took place in baths in the solfataric area of Hakone volcano. Both cases were blamed on extremely calm air conditions at the approach of low atmospheric pressure.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 12051

12033 Net energy delivery from geothermal resources. Bowen, R.G. pp 354-358 of In Geothermal world directory. 1977/78 edition. Reseda, CA; Geothermal World Publications (1977).

Plant and system efficiencies were used in calculating net energy delivery of a geothermal steam electric plant. Data on net efficiencies of nuclear fission, coal-fired electric, geothermal hot-water heating, and solar home heating concepts are presented and compared. (JGB)

12034 Net energy analyses for liquid-dominated and vapor-dominated hydrothermal energy-resource developments. Icerman, L. (Univ of Calif, San Diego). *Energy (Oxford);* **1**: No. 4, 347-365(Dec 1976).

Net energy analysis is considered to be a specialized form of energy analysis. The term net energy analysis is used to describe the evaluation of the energy required for the operation of processes in which the objective is the direct production transmission, or utilization of energy. Detailed evaluations of the energy requirements for construction and operation of 100-Mw flashed-steam, binary-cycle and total-flow power plant design for utilization of liquid-dominated hydrothermal reservoirs indicate that the meaningful net energy ratios range from about seven to eleven. A similar analysis of the

energy requirements for the construction and operation of a 100-Mw$sub e$ power plant utilizing a vapor-dominated hydrothermal reservoir leads to net energy ratios for vapor-dominated hydrothermal electrical-power generation stations as high as nineteen. The major indirect energy requirements are associated with power plant construction for liquid-dominated developments, while production well drilling contributes most heavily to these requirements of vapor-dominated resource utilization. Direct consumption of fuel is predominantly concentrated in production well drilling for both classes of hydrothermal facilities.

DESIGN AND OPERATION

12035 Production of energy by direct contact of water immiscible working fluid with hot or warm water to vaporize liquid working fluid, utilization of vapor to produce mechanical energy and direct contact of spent vapor with cold or cool water to condense same. Smith, C.S. Jr. US Patent 4,009,082. 22 Feb 1977. Filed date 1 Dec 1975. 24p.

A low boiling water immiscible fluid containing two or more molecular species and having a variable boiling point is contacted in the liquid state with relatively hot or warm water such as surface sea water or geothermal water, thereby generating vapor of immiscible fluid (together with a certain amount of water vapor) which is used to drive a prime mover such as a gas turbine and thereby produce mechanical energy; the exhaust vapor from the prime mover is condensed by direct contact with a relatively cool or cold liquid aqueous phase such as deep sea water or water from a lake or stream or cooling tower to condense the vapor; and the condensate is recycled. Provision is made for ridding water discharged from the system of entrained and dissolved immiscible fluid. By countercurrent flow of the liquid phases and by suitable matching techniques greater efficiency is obtained. The invention is also applicable to heat pumps.

POWER PLANT SYSTEMS AND COMPONENTS

REFER ALSO TO CITATION(S) 12674, 13564

12036 (COO—2619-1) **Study of practical cycles for geothermal power plants. Final report.** Eskesen, J.H. (General Electric Co., Schenectady, N.Y. (USA)). Apr 1977. Contract EY-76-C-02-2619. 160p. Dep. NTIS, PC A08/MF A01.

A comparison is made of the performance and cost of geothermal power cycles designed specifically, utilizing existing technology, to exploit the high temperature, high salinity resource at Niland and the moderate temperature, moderately saline resource at East Mesa in California's Imperial Valley. Only two kinds of cycles are considered in the analysis. Both employ a dual flash arrangement and the liberated steam is either utilized directly in a condensing steam turbine or used to heat a secondary working fluid in a closed Rankine (binary) cycle. The performance of several organic fluids was investigated for the closed cycle and the most promising were selected for detailed analysis with the given resource conditions. Results show for the temperature range investigated that if the noncondensible gas content in the brine is low, a dual flash condensing steam turbine cycle is potentially better in terms of resource utilization than a dual flash binary cycle. (The reverse is shown to be true when the brine is utilized directly for heat exchange.) It is also shown that despite the higher resource temperature, the performance of the dual flash binary cycle at Niland is degraded appreciably by the high salinity and its output per unit of brine flow is almost 20 percent lower than that of the steam turbine cycle at East Mesa. Turbine designs were formulated and costs established for power plants having a nominal generating capacity of 50 MW. Three cycles were analyzed in detail. At East Mesa a steam turbine and a binary cycle were compared. At Niland only the binary cycle was analyzed since the high CO_2 content in the brine precludes the use of a steam turbine there. In each case only the power island equipment was considered and well costs and the cost of flash separators, steam scrubbers and piping to the power plant boundary were excluded from the estimate.

12037 (UCRL—13751) **Definition of requirements for geothermal power conversion system studies.** (Bechtel Corp., San Francisco, Calif. (USA)). 30 Jun 1977. Contract W-7405-ENG-48-6614603. 45p. Dep. NTIS, PC A03/MF A01.

Candidate power conversion systems and criteria for comparing these systems are listed. The elements of each conceptual design and standard approaches to equipment design are described. The methods used to calculate heat and mass balances and the data used in the calculations are described. The method used in developing the economics of each system is described and factors such as construction wage rates common to all systems are included. Standard methods for developing the conceptual designs and corresponding economics are defined so that the results of each system study can be readily compared to those of the others. The candidate conversion systems are: multistage flash/binary; two stage flash with scrubbing; total flow; multistage flash/direct contact (Bechtel patented process); four stage flash/binary; binary with direct contact heat exchangers; hybrid-flash/binary; hybrid-flash/total flow; and flash/dual cycle binary. (MHR)

12038 (UCRL—52000-77-5, pp 1-6) **Geothermal energy development at LLL.** Austin, A.L. May 1977.

In Energy and technology review.

The basic objective of the LLL geothermal program is to develop the advanced machinery and techniques needed for extracting energy from the hot, concentrated brines of the Salton Sea Geothermal Field in California's Imperial Valley. Geologic estimates place the capacity of this one resource at 84,000 MW/yr of electrical energy, the equivalent of a billion barrels of oil. The plan to exploit this resource calls for drilling into the reservoir, converting the heat energy of the hot brines that naturally flow up out of the drill holes into mechanical energy by turbine, and then converting this mechanical energy into electrical energy in a conventional fashion. The brines contain up to 30 wt. percent of dissolved materials—solids, such as sodium chloride and potassium chloride, and gases, such as carbon dioxide and hydrogen sulfide. These materials ravage machinery through scale buildup, corrosion, and erosion and make spent-brine disposal difficult. Progress is being made toward solving these problems, however, and now a transition is underway from applied research to a program of development, system design, and field demonstrations.

12039 (UCRL—52000-77-5, pp 7-21) **Energy conversion engineering.** Lundberg, A.W. May 1977.

In Energy and technology review.

Efficiently extracting energy from the hot, corrosive brines of the Salton Trough presents problems that rule out all conventional turbines and expansion engines. Normal practice is to separate brine and steam and use only the latter, wasting the energy tied up in the brine. It would be far more efficient to use the total flow, extracting energy from both brine and steam. But conventional turbines, designed to operate on pure steam, would quickly wear out or plug up with scale if exposed to brine. Two unconventional brine-tolerant devices are being developed. Tests with a single-jet axial-flow impulse turbine indicate that a multijet version would have an efficiency of 38 to 41 percent. The two-phase impulse turbine appears capable of 70 percent efficiency with further development. The radial-outflow reaction turbine looks promising as an auxiliary device, extracting energy from the separated brine while a conventional turbine runs on the steam.

12040 Parametric study of a heat exchanger designed for geothermal power plant application. Kihara, D.H.; Chang Chai, H.; Shimozono, G.S. (Univ of Hawaii at Manoa, Honolulu). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-1, 1-12(1977).

The preliminary design of a vertical, counterflow, shell and tube heat exchanger for use in a rankine cycle is presented. The heat exchanger is to be part of a representative geothermal power plant generating 10 Mw utilizing geothermal brine at 350°F with isobutane as the working fluid. The computational procedure for determining tube lengths, number of tubes, and pressure drops is outlined. Detailed in graphical form are results of a parametric study showing how these parameters are affected by changes in turbine inlet temperature, tube diameter, tube pitch, isobutane velocity, scale thickness, pinch point temperature difference, and system pressure. 13 refs.

12041 Evaluation and design considerations for liquid-liquid direct contact heat exchangers for geothermal applications. Jacobs, H.R. (Univ of Utah, Salt Lake City). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-2, 1-8(1977).

Alternates to conventional heat exchangers are necessary for the design of many binary cycle Geothermal Power Plants. Direct Contact heat exchangers are proposed and various designs are considered for the important liquid-liquid regime which accounts for 40 percent of the duty for subcritical cycles. The design comparison indicates that heat transfer data for baffled tower and mechanically agitated towers should be pursued. Design of compact settler-separators also need further investigation. 29 refs.

12042 Operational limitations of direct contact boilers for geothermal applications. Jacobs, H.R.; Plass, S.B.; Hansen, A.C.; Gregory, R. (Univ of Utah, Salt Lake City). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-5, 1-8(1977).

Experimental heat transfer data for a near scale size direct contact boiler utilizing R-113 are presented. Operational limitations in terms of the minimum water to R-113 mass flow ratio are also presented. Minimum temperature pinch and vapor superheat are mentioned. A heat transfer correlation is given which appears to work for a variety of fluids. 18 refs.

12043 Geothermal energy recovery process. Awerbuch, L.; Lindemuth, T.E.; May, S.C.; Rogers, A.N. (Bechtel Corp., San Francisco). *Desalination;* **19**: No. 1/2/3, 325-326(1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

A novel process for the production of both power and water from geothermal brines is described. The Bechtel process isolates power plant components from the corrosive soluble gases and scale-forming vapors by exposing them only to pure steam, generated by transferring heat from flashed geothermal vapor to distilled water. One of the novel features of this system is the preheating of condensed turbine exhaust in the direct contact recovery unit. The performance of the energy recovery system is discussed for two types of geothermal brine, typical of sites in the Imperial Valley. Several alternatives are compared with the Bechtel process. (LS)

GEOTHERMAL ENGINEERING

12044 Geothermal component test facility. Angevine, J.M. (Univ. of California, Berkeley); Cummings, C.R. pp 272-275 of In Geothermal world directory. 1977/78 edition. Reseda, CA; Geothermal World Publications (1977).

The geothermal resource of the Imperial Valley is considered to be a particular engineering challenge in that this resource is liquid-dominated and typically of moderate to high salinity. In order to assist industry in tapping this geothermal area, the Energy Research and Development Administration (ERDA), in cooperation with the Bureau of Reclamation, established the nation's first government-operated geothermal component test facility at East Mesa in the Imperial Valley. The Geothermal Component Test Facility (GCTF) is being made available to industry for the purpose of testing various geothermal components and subsystems. Possible research programs are discussed.

DRILLING TECHNOLOGY AND WELL HARDWARE

REFER ALSO TO CITATION(S) 12053

12045 (SCRC-CR—77-11) **Geothermal down-well instrumentation. Final report.** (Sperry Research Center, Sudbury, Mass. (USA)). Apr 1977. Contract EY-76-C-02-2750. 81p. Dep. NTIS, PC A05/MF A01.

Work to develop a telemetry link between a Sperry downwell geothermal turbo-pump and the well-head, without the requirement for cables within the pipe-string, is described. Two methods were studied, built, and tested in a well at Heber, California, during the first field tests on the pump. These were: (a) an acoustic scheme which transmitted a modulated 4 kHz acoustic carrier on the pipe-string and (b) an electromagnetic scheme which used the exhaust steam pipe annulus as a coaxial transmission line operating at 100 MHz. After some problems with the small alternator powering the electronics, acoustic signals from downwell were received on November 13, 1976, which showed that the pipe-string could form a channel with about 21 dB insertion loss over 900 feet. Although surface tests had showed that low loss electromagnetic transmission should also have been possible, no signals were received, probably because of low pump speed giving low power-supply voltage. Acoustic transmission is the more practical to install, and it was concluded that this technique does provide a convenient method for transmission of downwell pump conditions to the well-head. Future development work on the geothermal pump will include provision for this telemetry channel.

12046 Multiple-completion geothermal energy production systems. Van Huisen, A.T. US Patent 4,044,830. 30 Aug 1977. Filed date 2 Jul 1973. 10p.

A system is described for the mining of geothermal energy in which a plurality of geothermal wells radiate from a single surface site into a subsurface geothermal reservoir. The wells can be drilled by conventional slant drilling techniques and each may contain a closed end heat exchanger which receives water and generates steam. Some of the heat exchangers are disposed vertically and others are implanted horizontally. By alternating production of the wells in a programmed cyclical manner, convective movement of the hydrothermal fluid will occur within the geothermal zone. The generated steam is collected in a reservoir at the surface site and utilized to generate electricity. The condensate from the turbine can be recycled to the wells.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 12038

12047 (CONF-7605168—1) **Investigation of the effect of sulfides on electric wire and cable in the Otake and Hatchogawara geothermal power plants.** Fujiki, S.; Kawasaki, O.; Irie, A. (Japan Electric Association, Tokyo). 1976. 2p. (In Japanese). TIC.

From 55. annual meeting of Japan Electric Association; Tokyo, Japan (May 1976).

The distribution of sulfides and their long term effects on electrical wires and cables were studied at the Otake and Hatchogawara geothermal power stations in Kyushu. The results of the first year's experiments are reported. It was found that significant sulfation effects were only located near steam wells, fumaroles and steam—water separators. It was concluded that aluminum was the most sulfide resistant conductive material and that cable should be located away from active sulfide atmospheres.

12048 (UCRL—79360) **Materials evaluation for geothermal applications: turbine materials.** Goldberg, A.; Garrison, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 13 Apr 1977. Contract W-7405-ENG-48. 4p. (CONF-770569—2). Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council; San Diego, CA, USA (9 May 1977).

A number of candidate turbine materials are being evaluated for their resistance to erosion, corrosion, and stress corrosion cracking (SCC) in geothermal brines. These materials include Fe-, Ni-, Co and Ti-base alloys, coatings and ceramics. Tapered wearblades, simulating the leading edge of a turbine blade, are exposed to the direct impact of a two-phase nozzle exhaust. Bent beam SCC specimens, which are constrained in fixtures attached to the wearblade holders, are also exposed to this exhaust. Results of a test series are reported in which acidified liquid brine was expanded to atmospheric pressure are reported. The tests were performed at the LLL Field Test Station near Niland in the Salton Sea Geothermal Field. Evaluation of the exposed materials indicates that Ti-base alloys show the most promise for turbine wheel components in the high salinity geothermal environments.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

12049 High temperature geothermal energy system. McCabe, B.C.; Zajac, E. (to Magma Energy, Inc.). US Patent 4,043,129. 23 Aug 1977. Filed date 5 May 1976. 38p.

A description is given of a method and apparatus for controlling a well providing access to an underground source of high temperature geothermal brine against flashing as the hot brine is delivered upwardly through the well to surface power apparatus. Plugging of the well by precipitated mineral deposits, as well as other operational problems, are thereby eliminated. A pump down in the well pressurizes the hot output liquid that is delivered to the surface generating equipment to prevent flashing. Liquid that is substantially cooler than the high temperature brine is injected into the well from the surface to form a continuously downflowing column about the outside of the pump and tailpipe assembly, and the tailpipe is sufficiently long so that the weight of the column of injected liquid applies sufficient pressure against the high temperature brine proximate the lower end of the tailpipe to prevent flashing of the brine. The cooler injection liquid is mixed with the high temperature brine proximate the tailpipe to produce hot output liquid of intermediate temperature, enabling the pump to operate at a low enough temperature, and under a low enough pressure head, to come within the capability of present pump technology. The invention also includes a concrete ditch reinjection conduit for precipitating out minerals from highly concentrated brine, while delivering the brine to a reinjection well.

12050 Permeability reduction factors at Wairakei. Grant, M.A. (DSIR, Appl Math Div, Wellington, NZ). *Am. Soc. Mech. Eng., [Pap.]*; No. 77-HT-52, 1-4(1977).

Gross permeability in the Wairakei geothermal system is provided by fissures. Fluid flow in a fissured medium may differ from that in a classical porous medium such as sand. In particular, two-phase flow may be very different, as the two phases do not interfere with each other in a fissure as they do in porous rock. This paper studies the history of bores which have changed enthalpy, and ascribes the changes totally to changes in permeability reduction factors, assuming that all else influencing the bore remains constant. This gives estimates of the permeability reduction factors. It is clear that the measured permeability reduction factors differ significantly from those for porous rock. 6 refs.

12051 Making electricity from moderate temperature fluids. Kunze, J.F. (Idaho National Engineering Lab., Idaho Falls); Whitbeck, J.F.; Miller, L.G.; Griffith, J.L. pp 369-378 of In Geothermal world directory. 1977/78 edition. Reseda, CA; Geothermal World Publications (1977).

Research is being conducted on the use of moderate temperature (300°F) geothermal fluids for power generation in the Raft River geothermal region in southern Idaho, near the Utah-Nevada border. Surface layouts of two exploratory wells are given. Plans for development of six or seven wells needed for producing and reinjecting 5,000 gpm for operation of a 10 MW pilot facility are discussed. (JGB)

12052 Geothermal energy pump and monitor system. Matthews, H.B. (to Sperry Rand Corp.). US Patent 3,988,896. 2 Nov 1976. 12p.

The operation of a geothermal well power-generation system is monitored by sensor, communication, and performance monitoring equipment permanently associated with the operating power generation system. Sensors detect changes in well water temperature, in water pressure below and above the pump, and in pump rotating speed. This data is transmitted by multiplex communication to receiver and utilization means at the earth's surface. A novel permanent magnet generator system supplies the signal representative of pump rotation speed and also supplies electrical power for the multiplex communication of the sensor output signals.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

REFER ALSO TO CITATION(S) 12046

12053 (LA-UR—77-2028) **Los Alamos hot dry rock geothermal project.** Brown, D.W.; Pettitt, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 26p. (CONF-771027—2). Dep. NTIS, PC A03/MF A01.

From American Society of Civil Engineers annual convention; San Francisco, CA, USA (17 Oct 1977).

The greatest potential for geothermal energy is the almost unlimited energy contained in the vast regions of hot, but essentially impermeable, rock within the first six or seven km of the Earth's crust. For the past five years, the Los Alamos Scientific Laboratory has been investigating and developing a practical, economical and environmentally acceptable method of extracting this energy. By early 1978, a 10 MW (thermal) heat extraction experiment will be in operation. In the Los Alamos concept, a man-made geothermal reservoir is formed by drilling into a region of suitably hot rock, and then creating within the rock a very large surface for heat transfer by large-scale hydraulic-fracturing techniques. After a circulation loop is formed by drilling a second hole to intersect the fractured region, the heat contained in this reservoir is brought to the surface by the buoyant closed-loop circulation of water. The water is kept liquid throughout the loop by pressurization, thereby increasing the rate of heat transport up the withdrawal hole compared to that possible with steam.

12054 **Preliminary assessment of a geothermal energy reservoir formed by hydraulic fracturing.** Murphy, H.D.; Lawton, R.G.; Tester, J.W.; Potter, R.M.; Brown, D.W.; Aamodt, R.L. (Los Alamos Sci Lab, NM). *Soc. Pet. Eng. J.;* **17**: No. 4, 317-326(Aug 1977).

Two 3-km-deep boreholes were drilled into hot granite in northern New Mexico to extract geothermal energy from hot, dry rock. Both boreholes were hydraulically fractured to establish a flow connection. Fracture-to-borehole intersection locations and in-situ thermal conductivity are determined from flowing temperature logs. In-situ measurements of rock permeability and compressibility show a strong dependence on pore pressure. An estimate of the minimum horizontal earth stress is derived from fracture extension pressures and found to be one-half the overburden stress. It is found that fracture growth is remarkably simple to achieve in the low-permeability granite and that these fractures appear to be "self-propped." The present connection has a large flow impedance that probably cannot be reduced to a useful level. Establishment of a prototype heat exchange system will require redrilling to intersect directly one of the fractures. 18 refs.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 12031, 12043

12055 (BNWL—2311) **Geothermal energy potential for district and process heating applications in the U.S.: an economic analysis.** Bloomster, C.H.; Fassbender, L.L.; McDonald, C.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-06-1830. 61p. Dep. NTIS, PC A04/MF A01.

Geothermal energy is competitive for space and process heating applications over significant distances when employed on a large scale to serve concentrated markets. Under these conditions geothermal energy from 90 to 150°C hydrothermal resources should be economically competitive for high-density urban district heating out to distances of 50 miles from the wellhead. Supply curves (price-quantity relationships) were developed for both process heating and district heating applications for distances out to 50 miles. The 90 to 150°C hydrothermal resources, which were identified in the assessment of geothermal resources by the U.S. Geological Survey, contain usable energy for space and process heat equivalent to 50 billion barrels of oil. The potential demand for space and process heat near these hydrothermal resources is large; over 10% of the U.S. population resides within 40 miles of the resources. The sensitivity of production costs to the important factors of production was determined. The most important factors are well costs, well flow rate, resource temperature, distance separating demand and supply, population density, size of demand, and the system load factor. Technological advances are needed to reduce costs and increase the distances over which geothermal energy can be competitive. Institutional deterrents to widespread nonelectric applications of geothermal energy will probably be significant. Among these will be the acquisition of rights-of-way, the need to organize concentrated markets, and price competition from the conventional fuels based on average cost rather than marginal cost.

12056 **Application of the heat pump for heating of dwellings with heat extracted from the ground.** Schaer, O. (Bernische Kraftwerke, Switz). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 4, 182-184(19 Feb 1977). (In German).

The use of the heat pump for heating of small dwellings is considered. The design of an appropriate heat pump with a buffer store is outlined. The thermal characteristics of the earth in the presence of heat extraction are investigated, and pertinent measurements are reported.

12057 **Geothermal energy: direct heat utilization potential for California (Abstract).** Willard, S. (California Energy Resources Conservation and Development Commission, Sacramento). *Geol. Soc. Am., Abstr. Programs;* **9**: No. 4, 527(Feb 1977).

Concurrent with California's abundant faults, earthquakes, volcanoes, and other tectonic phenomena, are numerous hot springs and geothermal anomalies, which are projected to supply a growing share of California's electrical energy needs. However, direct heat utilization of geothermal energy may eventually become more significant than electricity generation from geothermal resources. Since the temperatures of most identified California hydrothermal systems are too low for electricity generation, yet adequate for process heat, most systems in California would be best used for direct heat applications, such as space and water heating, industrial processing, refrigeration, and agribusiness. Particularly favorable locations for direct heat applications include the Imperial Valley, Susanville, Mammoth, Lake County and Calistoga. Feasibility studies are currently underway in some of these localities to assess the practicality of direct heat applications, and to verify their potential significance. It is possible to combine uses in a cascading system, whereby the warm water output of one process is the input to the next process. Since many geothermal resources are located in remote, scenic areas, careful planning and mitigation of adverse impacts is essential. Direct heat utilization has less of a potential for damaging the environment than electricity generation facilities, since there is less attendant construction necessary, and the produced fluids can be kept entirely in a closed system with no release of gases or waters to the environment.

GEOTHERMAL DATA AND THEORY

12058 **Deep-water temperatures in the FAMOUS area.** Fehn, U. (Harvard Univ., Cambridge, MA); Siegel, M.D.; Robinson, G.R.; Holland, H.D.; Williams, D.L.; Erickson, A.J.; Green, K.E. *Geol. Soc. Am., Bull.;* **88**: 488-494(Apr 1977).

Some of the results of Project FAMOUS studies, which were undertaken in the axial area of the Mid-Atlantic Ridge between approximately 36°30′ and 37°N latitudes, are reported. The distribution of water temperatures in the FAMOUS area was investigated during the years 1972 to 1974. Forty-seven vertical temperature profiles were taken and bottom-water temperature measurements along 110 km of traverses were carried out during the course of four cruises. Potential temperatures in the FAMOUS area were found to range between 3.53 and 3.85°C below a depth of 2,200 m. These temperatures are almost 1°C higher than temperatures outside the axial zone of the Mid-Atlantic Ridge at comparable depths. The potential temperature in deep waters was observed to increase from 3.53°C in the western part of fracture zone B to 3.80°C in the eastern part of fracture zone A. Vertical temperature gradients are smaller than 1×10^{-4} °C/m at depths below 2,200 m in the various basins of the FAMOUS area. Between 2,000 and 1,800 m, the temperature differences between the different parts of the area gradually disappear; above 1,500 m, there are no significant differences between water temperatures in the ridge and those in the surrounding ocean. The observed near-bottom temperature distribution in the FAMOUS area is related to the bottom topography. The temperatures in the various basins are determined mainly by their sill depth; the observed south-north increase of deep-water temperatures and the velocity of bottom-water currents in the area can be related quantitatively to hydrologic effects. The influence of hydrothermal activity and of heat flow through the ocean floor on the temperature distribution in the area is negligible.

12059 **Geothermal study of the Mid-Atlantic Ridge near 37°N.** Williams, D.L. (Geological Survey, Denver); Lee, T.C.; Von Herzen, R.P.; Green, K.E.; Hobart, M.A. *Geol. Soc. Am., Bull.;* **88**: 531-540(Apr 1977).

Some of the results of Project FAMOUS studies, which were undertaken in the axial area of the Mid-Atlantic Ridge between approximately 36°30′ and 37°N latitudes, are reported. A suite of 101 well-navigated heat-flow stations was used to investigate lithospheric cooling on the Mid-Atlantic Ridge near 37°N. Measurements in two topographic depressions marking the intersection of transform faults with axes of sea-floor spreading show evidence of hydrothermal circulation in basement rocks. One of these depressions appears to have been subjected to a recent bottom-water temperature change which severely biases the heat-flow data. Some of the evidence suggests that transform faults are more permeable than other regions of the ocean crust and therefore may cool much faster. The heat flow in rift mountains extending from 10 to 35 km west of the spreading axis was also measured. The data here also suggest that a hydrothermal system is presently active in the crustal rocks. Although hydrothermal vents have not yet been unambiguously identified on the sea floor, hydrothermal circulation seems likely to be the dominant mode of cooling oceanic crust near spreading axes where sediment cover is thin (that is, few tens of metres) or nonexistent.

PROPERTIES OF AQUEOUS SOLUTIONS

12060 Pressure—temperature curves for a two-phase mixture of water and carbon dioxide. Sutton, F.M. (Dept. of Scientific and Industrial Research, Wellington, New Zealand). *N.Z. J. Sci.;* **19**: No. 3, 297-301(Sep 1976).

Pressure-temperature curves are presented for a two-phase system of CO_2 and water under conditions typical of Broadlands geothermal field.

PROPERTIES OF MINERALS AND ROCKS

12061 Thermodynamic treatment of chemical reactions in orthopyroxene. Oka, Y. (Hokkaido Univ., Sapporo, Japan). *Geochem. J. (Nagoya);* **11**: No. 2, 101-106(Jun 1977).

Mixing of Fe and Mg in orthopyroxene crystalline solution can be represented by a multicomponent regular solution model when the molecules (Mg/sup M1//Mg/sup M2/Si_2O_6, Fe/sup M1//Fe/sup M2/Si_2O_6, Fe/sup M1//Mg/sup M2/Si_2O_6 and Mg/sup M1//Fe/sup M2/Si_2O_6) are introduced as its components. In this regular solution model, there are three independent interaction parameters (W/sup M1/, W/sup M2/ and W/sup M12/) which correspond to the cation interactions between M1 and M1 sites, M2 and M2 sites and M1 and M2 sites, respectively. These parameters cannot be determined uniquely by site-occupancy measurements only. Some thermodynamic formulations for orthopyroxene are given by using these parameters.

ROCK-WATER-GAS INTERACTIONS

12062 Study of the dissociation of natural carbonates crushed in air at room temperature. Grezes-Besset, R.; Espagne, M. (Universite P. Sabatier, Toulouse). *Bull. Soc. Fr. Mineral. Cristallogr.;* **100**: No. 2, 88-94(1977). (In French).

From Meeting of the French society on mineralogy and christallography; Toulouse, France (11 May 1976).

This study is integrated with systematic laboratory research on the origin of hydrothermal fluids. It deals with the liberation of CO_2 from natural carbonates. The gravimetric analysis apparatus with derivative recording allows one to follow the dissociation of samples. A dynamic investigation on calibrated grains shows that the measurable rates of dissociation are obtained at relatively high temperatures with respect to hydrothermal domains. Grinding at ordinary temperature causes smithsonite and rhodochrosite to dissociate quickly enough whereas magnesite and dolomite liberate CO_2 much more slowly. Steam makes the dissociation of magnesite and dolomite easier, only if they were crushed for a long time. At 200°C and atmospheric pressure after 100 hours of grinding and 40 days of contact with steam, magnesite is decarbonated almost totally. At 150°C and pressure of 5 bars, the T. G. A. and D. T. G. diagrams of magnesite + dolomite show that the increase of the steam pressure, in spite of the lowering of temperature, increases considerably the rate of CO_2 release, and the longer was the grinding, the more complete is the dissociation. The time of contact with the steam has a considerable consequence on the formation of brucite.

ISOTOPE AND TRACE ELEMENT STUDIES

12063 Partitioning of strontium between calcite, dolomite and liquids under higher temperature diagenetic conditions. Jacobson, R.L.; Usdowski, E. (Univ., Goettingen). *Bull. Soc. Fr. Mineral. Cristallogr.;* **100**: No. 2, 106-109(1977).

From Meeting of the French society of mineralogy and chrystallography; Toulouse, France (11 May 1976).

Partitioning of Sr was studied in order to get information on its geochemical behavior, as far as being controlled by calcite and dolomite, and to see whether Sr can be used as a geothermometer. Experiments between 150° and 350°C demonstrate that partitioning is essentially independent of temperature in highly concentrated solutions. With more dilute solutions partition coefficients increase, but their ratio stays constant to 2/1. This 2/1 relationship is also observed in natural calcite and dolomite which have undergone some type of diagenesis. Temperature independence of partitioning is due to thermal expansion properties of calcite and dolomite, which expand in the same way. Therefore, the ratio of partition coefficients stays constant with increasing temperature and calcite and dolomite cannot be used as a geothermometer. Useful geothermometers are those mineral pairs which combine high and low thermal expansion. It is suggested that, when in search of a geothermometer, thermal expansion properties of minerals should be considered first.

TIDAL POWER

WAVE ENERGY CONVERTERS

12064 Process and device for harnessing wave energy. Tornabene, M.G. US Patent 4,048,801. 20 Sep 1977. Filed date 11 Apr 1975. 6p.

In a preferred embodiment of the invention, a plurality of spherical float elements mounted on levers which levers are each mounted for reciprocation along elongated axes thereof substantially vertically thereof to the sea bottom, with interconnected drive shafts for mutually contributing to a common drive, the plurality are arranged with forward and rearwardly and laterally off-set-spaced floats relative to one another and relative to a direction of wave movement from forwardly to rearwardly, such that energy in the form of water pressure waves above and below the water surface are deflected laterally and rearwardly from the forward float elements to the rearward elements to impel against the rearward elements together with the impelling of the normal waves or residual waves also impelling against each of forward and rearward waves, and the process of arranging the plurality of spherical float elements and of harnessing the deflected energy thereby.

12065 System for generating power from wave motions of the sea. Wood, E. (to Insituform (Pipes and Structures) Ltd.). US Patent 4,048,512. 13 Sep 1977. Filed date 6 Feb 1976. 10p.

A power generating system for the generation of energy from the wave motions of the sea is buoyantly supported by the sea. The system comprises spine elements defining a spine on which ducks are rockably mounted, the system further including tension cable means pressing the spine elements towards each other thereby to define a spine, and energy conversion means for converting the rocking motion into electrical power. 11 claims, 16 figures.

12066 Hydrodynamic basis of wave-energy converters of channel form. French, M.J. (Univ of Lancaster, Engl). *J. Mech. Eng. Sci.;* **19**: No. 2, 90-92(Apr 1977).

A study is made of a train of ideal deep-sea waves, 2b in width, entering a channel of the same width whose flexible walls move horizontally and normally to the wave direction in a simple harmonic motion so as to extract energy from the waves. 2 refs.

12067 Ocean-wave-operated-engine for the driving of an electric generator. Masuda, Y. (to Nichirokogyo Co. Ltd., Tokyo (Japan)). German(FRG) Patent 1,488,997/C/. 13 Jan 1977. 3p. (In German).

The invention concerns an arrangement for converting the mechanical energy of ocean waves into electrical energy. It is meant primarily to serve for electricity production in buoys. An open cylinder, whose inner room is accessible to the sea water from below, is half submerged in water. From oscillating up and down in the sea, air is pumped out or sucked in through an air line in the upper part of the cylinder. Thereby, the air runs through a turbine which in turn drives an electric generator. Four air valves insure that the air always flows through the turbine only in one direction. A float is arranged and firmly joined to the cylinder from underneath, it carries a weight below to keep the buoy in vertical position. The cylinder cross-section and the buoy mass is so measured that the period of vertical oscillation of the buoy equals the average oscillation period of the ocean wave.

12068 Wave and wind storage station. Hoppe, H. German(FRG) Patent 2,514,447/A/. 14 Oct 1976. 9p. (In German).

The specification concerns an arrangement which is to use the energy of sea waves. It is to be situated outside the breakers in waters of great depth. Pistons are moved to and for by the sea waves in cylinders which are open below and which reach into the water. In the upper air filled part of such a cylinder, there is alternate high and low pressure due to the piston movement, and a so-called excess pressure store is filled via non-return valves, while a low-pressure store is emptied. Using these two stores, water is pumped pneumatically from a lower fresh water container into an upper container

floating on it. The water drives a turbine, when flowing back from the upper to the lower container, which is coupled to a generator for power generation.

12069 Energy from the waves of the sea. Salter, S.H. (Univ Edinburgh, Scotl). *Meerestechnik;* **6**: No. 4, 131-134(Aug 1975). (In German with English abstract).

A novel method for generation of power from the sea waves is described. A spline pump is designed with a vane that resembles a camshaft. Water waves are exerting force on the vane, which in turn transmits torsional force on the pump shaft. Experimental results in a test tank are described.

12070 Analysis of a stationary pneumatic wave-energy converter. McCormick, M.E. (US Nav Acad, Annapolis, Md). *J. Eng. Ind.;* **97**: No. 3, 1015-1019(Aug 1975).
Paper No. 74-WA/OcT-2.

WIND ENERGY

REFER ALSO TO CITATION(S) 12542

AVAILABILITY (CLIMATOLOGY)

12071 (AEOI—63) **Utilization of wind energy.** (Atomic Energy Organization of Iran, Teheran. Centre for Research and for Application of Radioisotopes). Oct 1976. 10p. (In Iranian). (CRAR—76-7). Dep. NTIS (US Sales Only), PC A02/MF A01.

The statistics of the wind energy in the three aerology stations in the Shahbanu Farah Dam region - over a period of eight years - were evaluated and analyzed. The average of maximal velocity calculations indicates a speed of 15 m/s. The yearly physical conversion value of this energy, is 150,000 kW/h which is quite sufficient for a family of five persons. On a larger scale, this power can be used to supply the energy required for the sediment dredging activities of the Shahbanu Farah Dam.

12072 (NP—22490) **Analysis of the potential for wind energy production in northwestern Ontario.** Brown, C.K.; Warne, D.F. (Ontario Research Foundation, Sheridan Park (Canada); Electrical Research Association, Leatherhead (UK)). Nov 1975. 177p. Dep. NTIS (US Sales Only), PC A09/MF A01.

A study of the feasibility of generating electric power from wind generators at remote sites in Northwestern Ontario has been carried out on behalf of the Ontario Ministry of Energy, with project management from Ontario Hydro. The work included (1) a survey of commercially available wind driven electric plant, both currently available and planned for production, (2) an analysis of existing wind data and preparation of an isovent map for Ontario showing annual mean wind speeds, (3) the selection of suitable sites for a demonstration unit and a prototype system, (4) the matching of available plant to the wind regimes to predict annual energy production, and (5) a systems analysis of pure diesel, hybrid wind/diesel and pure wind electric plants to determine the cost of power from the various alternatives.

12073 (UCRL—52000-77-6, pp 18-25) **Wind-energy assessment.** Hardy, D.M. Jr. Jun 1977.

In Energy and technology review.

As part of the federal wind energy program, work on the island of Oahu, Hawaii, to develop general methods of assessing wind energy is reported; this will be suitable for other mountainous regions of the U.S., including the Pacific Coast, Rocky Mountain, and New England areas. Computer simulations and meteorological measurements have been made to study how wind energy varies in time and from place to place. Rough, mountainous country—like Oahu—can cause enormous local variations in wind energy. However, several subareas of high wind-energy potential have been identified, and work is being focused on one that appears especially suitable for wind-power development.

ECONOMICS

REFER ALSO TO CITATION(S) 12072, 12662

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 12072

12074 Wind power engine. Musgrove, P.J. (to National Research Development Corp., London (UK)). German(FRG) Patent 2,632,697/A/. 10 Feb 1977. 17p. (In German).

The device is a wind-power engine with vertical axis and with one or several wings with airfoil profile fixed on a frame which is pivoted at the vertical axis. Each wing forms at least on one part of its length an angle of inclination with the vertical. The angle increases under the influence of the centrifugal force when the r.p.m. exceed a normal operation range. This method helps to reduce mechanical loads occurring with high wind speeds without requiring a complicated construction.

12075 Mechanical overload protection for wind impellers. Schoenball, W. German(FRG) Patent 2,558,848/A/. 16 Sep 1976. 5p. (In German).

The invention concerns a wind impeller with horizontal axis of rotation, which is at right angles to the wind at normal windspeeds, but at high wind pressures is pressed upwards through a right angle, out of the wind direction, by a swivelling axle. According to the invention the impeller is held in position against the wind by a counter weight hung on ropes. When the impeller is pressed upwards, the counter weight is pulled up by the arrangement of ropes. When the wind pressure drops the impeller is pulled back into position against the wind by the load of the counter weight.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 11410, 12632, 12645

12076 Vaporization of LNG with a gas turbine in a closed circuit. Griepentrog, H. (Gutehoffnungshuette Sterkrade A.G., Oberhausen-Sterkrade (Germany, F.R.)). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 8, 324-330(Aug 1977). (In German).

From Gastech 76 conference; New York (Oct 5 - 6, 1976).

The economy of gas supply with LNG can be considerably improved upon if the cold stored in LNG is utilized. The gas turbine in a closed process offers itself for this purpose, the whole waste heat being used as vaporization heat. At the same time, the lowest circuit temperature is reduced to below - 140°C. Thus, a coupling efficiency rate of 58% can be achieved. Generating costs are within the range of those valid for nuclear power plants at present. Besides, this system meets a demand made by gas and electricity supply companies, as only components proven over several years are used.

12077 State and future prospects of the power economy of Afghanistan. *Arch. Energiewirtsch.;* **31**: No. 6, 471-474(Jun 1977). (In German).

With regard to the development of its power economy, Afghanistan takes about the last place in the world hierarchy. The present paper starts on a survey of existing power plants and their capacity. Most of the bigger power plants use hydropower. Diesel-fuelled power plants also play an important role. There is no general electricity network. A new 7 years' plan will promote the erection of large power stations. Electric power generation is to be about doubled in this period.

12078 Technical and economic aspects of coupling thermal with electric power in industry. I. Maier, K.H. *Energie;* **29**: No. 5, 130-140(May 1977). (In German).

The advantages offered by combining the thermal power generation with electric power generation and requirements are reviewed. Various methods of coupling thermal plants with electric power plants are discussed. The impact of such combination on economics, energy savings and air pollution is identified.

12079 Coupling of thermal and electric power generation using coal, oil and natural gas as fuel for four turbines and boilers. *Energie;* **29**: No. 5, 146-150(May 1977). (In German).

Design criteria for rational power utilization by choosing four, rather than one unit, for steam generation in a food processing plant are demonstrated.

12080 Automatisms and control systems in thermoelectric power stations. Cipriani, F. (Ente Naz per l'Energ Elettr, Venezia, Italy). *Elettrotecnica;* **64**: No. 4, 261-268(Apr 1977). (In Italian).

A distinction is made between automatisms and control systems. Some of them are described in detail: power output control system, condensate high level protection in feedwater preheaters, and boiler drum level control system.

12081 Distillation plant for the desalination of sea water combined with a thermal power station. Azhari, N. German(FRG) Patent 2,531,295/A/. 20 Jan 1977. 9p. (In German).

During the operation of these combined plants it is difficult to bring in line the energy release with the energy consumption. It is proposed, to fit an additional downdraft evaporator to the flash-type evaporator in the distillation plant in order to get an improved utilization of the energy generated in the steam power plant. The pressure side of the steam compressor in the thermal power station is connected with the vapor space of this evaporator on its suction side, and with the fire box on its inlet side. Distillate and hot brine are fed into the first stage of the flash-type evaporator.

12082 Neka power station. Petzel, H.K. *BBC-Nachr.;* **59**: No. 2, 89-92(1977). (In German).

At the end of August 1975, the Iran awarded the order for the construction of the 1760-MW Neka power station which is being built by a consortium led by BBC. BBC are responsible for the overall planning as well as the design and supply of the electrical and process control equipment. Also supplied by BBC are the four turbosets as well as the heating, air conditioning and ventilating equipment. Commissioning of the first 440-MW unit is scheduled for the beginning of 1979.

12083 Engineering aspects of a dual-purpose electrical power generating hyperfiltration desalting plant for Middletown, Arabia. El-Nashar, A.M. (Univ. of Mansoura, Egypt); Husseiny, A.A. *Desalination;* **19**: No. 1/2/3, 189-199(Dec 1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

The design of a dual-purpose plant that consists of a fossil-fueled power station and a reverse osmosis (hyperfiltration) desalting unit is considered. The plant is to be sited on the sea coast near Middletown, Arabia. This is a hypothetical metropolitan area which represents an average town in the region of the Mediterranean, Red Sea, Indian Ocean, or the Arabian Gulf. The reference town has a typical population density and electricity and water consumption patterns of cities presently located in the region of interest. The sale of electrical energy is assumed to be fixed by the utility companies and/or the government regulations. The design of the plant will be optimized to produce water at the lowest possible cost. Membranes with intrinsic rejections of 70 percent to 97 percent are considered. The optimum membrane permeability, operating pressure, water recovery and storage capacity are obtained.

12084 Choosing a diesel generating set for standby and peak-lopping applications. Owen, W.T. (Mirrlees Blackstone Ltd, Stockport, Cheshire, Engl). *Electron. Power;* **21**: No. 15, 858-860(4 Sep 1975).

During recent years, there has been a revival of interest in standby diesel generating plants, mainly as a result of the various crises which have disrupted power supplies from 1970. The article covers some of the factors which may affect both the type of plant and also the mode of operation, such as: the crankshaft speed at which the engine will operate; generator voltage; control systems; parallel operation; starting systems; fuels; fuel storage; cooling systems; noise levels; and ventilation.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

12085 ESCOM: their second dry cooling tower. Holz, P. *Energy Int.;* **14**: No. 11, 45-46(Nov 1977).

A second dry cooling tower has been installed by the Electricity Supply Commission (ESCOM) of South Africa at the Grootvlei power station in the Transvaal. Dry cooling towers allow coal-fired power stations to operate with less demand on water resources, which are strictly allocated in the area. The first dry cooling tower, an indirect jet condenser model, has operated successfully for several years. Performance testing has revealed a sensitivity to changes in wind velocity as well as temperature gradients. Design and engineering specifications of the new tower are compared to those of the earlier model. A more economical surface condenser is the major change. (DCK)

12086 (ORNL-tr—4490) **Heat extraction system of the Stavropol' thermal power plant.** 1977. Translation by S.D. Blalock Jr. of USSR report. 16p. Dep. NTIS, PC A02/MF A01.

The design, selection, cost, operation, and performance of the heat extraction system at the 2400 MWe Stavropol thermal power plant are discussed. Information is included on characteristics and quantity of cooling water used, cooling system components, heat extraction system, and environmental protection measures. (LCL)

12087 (ORNL-tr—4493) **Heat extraction system of the Chigirinsk thermal power plant.** 1977. Translation by S.D. Blalock Jr. of USSR report. 17p. Dep. NTIS, PC A02/MF A01.

The operation of heat extraction system at the 3200 MWe Chigirinsk thermal power plant in the Central Ukraine is discussed. Information is included on the water supply source and flow rates; regional climate; cooling system components and their operation; water reservoir characteristics; system costs; and power plant ash removal system. (LCL)

12088 (ORNL-tr—4495) **Designing and operating heat extraction systems at the Tallin thermal power plant No. 2, "IRU".** 1977. Translation by S.D. Blalock Jr. of USSR report. 10p. Dep. NTIS, PC A02/MF A01.

The design and operation of the cooling systems at the 700 MWe Tallin thermal power plant No. 2 in the USSR which produces both steam and electric power are discussed. Information is included on the characteristics and flow of cooling water obtained from the Yagala River; climate; cooling system components; steam production; heat extraction system; and environmental protection measure to prevent water pollution and damage to fish. (LCL)

12089 Condensing plant, particularly equipment for condensing waste steam of a power station. Larinoff, M.W. (to Hudson Products Corp., Houston, Tex. (USA)). German(FRG) Patent 2,626,787/A/. 30 Dec 1976. 11p. (In German).

The invention concerns equipment for condensing steam at the turbine outlet of a power station, where part of this steam is condensed inside a steam condenser by a coolant. This coolant is cooled, in turn, inside a wet cooling tower. The other part of the steam is condensed in a dry cooling tower. In particular, the invention concerns improvements in equipment of this type. These should make it possible to take the wet cooling tower out of operation during cold weater, in order to reduce the use of treated water in areas where water is scarce.

12090 Condensing plant, particularly equipment for condensing waste steam of a power station. Larinoff, M.W. (to Hudson Products Corp., Houston, Tex. (USA)). German(FRG) Patent 2,626,788/A/. 30 Dec 1976. 33p. (In German).

The invention concerns equipment for condensing steam at the turbine outlet of a power station, where part of this steam is condensed inside a steam condenser by a coolant. This coolant is, in turn, cooled inside a wet cooling tower. The other part of the steam is condensed in a dry cooling tower. In particular, the invention concerns improvements in equipment of this type. These should make it possible to take the wet cooling tower out of operation during cold weather, in order to reduce the use of treated water in areas where water is scarce.

12091 Method of using irrigation drainage water for power plant cooling. Sephton, H.H.; Klein, G. (Univ. of California, Richmond). *Desalination;* **19**: No. 1/2/3, 257-268(1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

The accumulation of large quantities of saline water collected from irrigated fields by underground tile drainage systems presents environmental problems in the South-Western U.S. and Mexico. Research is reported which indicates the technical and economic feasibility for using such wastewaters for power plant cooling. A novel process sequence is employed comprising (a) ion-exchange resin softening whereby nearly all the calcium is removed, followed by (b) using this softened water as feed to the power plant cooling tower, concentrating it by a factor of 5 to 15; this cooling tower blowdown is subsequently (c) further concentrated by vertical tube foam evaporation (VTFE) to provide a 20-fold concentrate of the initially softened wastewater which is then adequate to (d) serve as the sole regenerant for the ion-exchange resin used in the initial softening step. Step (d) is carried out in an upflow fluidized bed mode which ensures favorable reaction kinetics by the formation and removal of calcium sulfate precipitate from the resin bed. A new pilot plant facility of 2,000 gpd capacity is described including a softening and regeneration facility, a cooling tower operating under realistic process conditions and a complete VTFE facility; test data are presented indicating technical feasibility. Long term field tests with this facility are planned in the San Joaquin Valley to determine the viability of this approach for the beneficial use and simultaneous disposal of irrigation drainage.

12092 Desalination through the vapour compression process in large plants. Le Martret, J.P. (Societe Internationale de Dessalement, Paris). *Desalination;* **19**: No. 1/2/3, 337-348(1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

The vapor compression process for desalination by evaporation shows great advantages over classical processes like multistage flash.

12093 Reduced height cooling towers for high capacity power plants. Henning, H. (Balcke-Duerr, Bochum, Ger). *VGB Kraftwerkstech.;* **55**: No. 8, 530-538(Aug 1975). (In German with English abstract).

Construction heights of about 80 m for natural draught cooling towers are presented in correlation with unit capacities of 1200 MW; the environmental behavior of low natural draught cooling towers is compared with that of natural draught cooling towers

having an optimum fineness ratio of about 1.3. Alternatively, the use of mechanical draught plants in a cellular or round type of construction is discussed both in the case of wet and also dry cooling. Data are presented in graphical and tabular form.

POWER CYCLES

REFER ALSO TO CITATION(S) 11442

12094 (FE—2290-26) **High Temperature Turbine Technology Program. Phase I. Program and system definition. Topical report: low Btu gas combustor technology development plan.** (Westinghouse Electric Corp., Lester, Pa. (USA). Generation Systems Div.). Feb 1977. Contract EX-76-C-01-2290. 117p. Dep. NTIS, PC A06/MF A01.

The detailed Westinghouse Technology Development Plan for an Advanced Low-Btu Gas Combustor is presented. The main thrust of the effort described herein is the development of an advanced canannular type combustor intended for integration with the high temperature turbine subsystem in a coal gasification combined cycle power plant. This type of combustor was selected for development to the status of "technology readiness" after a preliminary design evaluation of three different concepts. The plan calls for the design, fabrication and testing of three initial versions of the advanced concept combustor as a means of design optimization. Following additional performance improvement testing, the final prototype configuration will be fabricated and tested for performance verification. A growth potential test will then be conducted to establish the limitation of the design with respect to the 3000°F growth temperature goal of the HTTT Program. The advanced combustor employs Lamilloy transpiration-cooled parts. This material cooling concept has been demonstrated in both advanced aircraft and industrial combustors. To assure the ultimate feasibility of economically producing large-scale Lamilloy combustors, the recommended program includes work to develop the improved fabrication techniques required. Also provided in the plan is a comprehensive analytical evaluation to explore the feasibility of additional advanced design features which will further reduce combustor cooling-air requirements as necessary to permit firing-temperature growth to the 3000°F level.

COMPONENTS

REFER ALSO TO CITATION(S) 12094, 12955

12095 (FE—2556-06) **Development of a ceramic tube heat exchanger with relaxing joint. Quarterly technical progress report, April—July 1, 1977.** Ward, M.E.; Napier, J.C. (Solar Turbines International, San Diego, Calif. (USA)). 19 Jul 1977. Contract EF-77-C-01-2556. 46p. Dep. NTIS, PC A03/MF A01.

All fixtures needed to perform the Materials Evaluation have been fabricated. Tests will start as soon as ceramic specimens are received from vendor. Calibration tests using KT SiC are in progress and will be completed by the end of the next reporting period. The environmental rig has been fabricated. It was installed in the test facility and calibration is in progress. Desired air velocities and air temperature have been achieved. High rig wall temperatures were experienced. Cooling is being increased to reduce rig wall temperatures. Six glass candidates have tentatively been selected to meet engineering requirements established for the low and moderate relaxation joint temperature ranges. The glass viscosity-temperature characteristics classification tests are in progress. Preliminary results indicate that the first three glasses chosen have the desired characteristics. The joint relaxation computer program has been completed. Parametric analysis was performed and results included in the body of this report. Preliminary design analysis has shown the preheat of a relaxation joint to be a viable and practical method for relieving cold start thermal transient stress build-up in the header/tube system. Although the relaxing joint heat exchanger is considered the primary design, other possible heat exchanger tube and shell systems are being evaluated as alternatives.

12096 (FE—2583-8) **Conceptual design for an atmospheric fluidized-bed direct combustion power generating plant. Phase I. Commercial plant conceptual design. Quarterly report, May 1—August 31, 1977.** Norton, R.C. (Stone and Webster Engineering Corp., Boston, Mass. (USA)). 8 Sep 1977. Contract EF-77-C-01-2583. 24p. Dep. NTIS, PC A02/MF A01.

Progress is reported in developing a conceptual design for a commercial size (560 MW) complete power generating station, incorporating an atmospheric fluidized combustion boiler. This design is to be developed as a variation of a base which is an established plant design with conventional pulverized coal suspension fired boiler with associated facilities. The activities of this second quarter have concerned the design of the corresponding AFB combustion power plant incorporating the individual AFB designs of the two boiler manufacturers, Babcock and Wilcox and Foster Wheeler.

12097 **Instrumentation and control system incorporating a process computer at the Clauscentrale power station.** van Ool, H.; van de Rhee, A.; Krieg, D.; Lahm, J. (Siemens A.G., Karlsruhe (Germany, F.R.). Geschaeftsbereich Mess- und Prozesstechnik). *Siemens-Z.;* **51**: No. 8, 636-641(Aug 1977). (In German).

As the unit ratings of power stations increase, the number of facilities to be controlled also increases. This is accompanied by growing demands on the design of the control room and its monitoring functions. The problems involved cannot be solved with conventional display and recording systems. A solution is therefore presented in which a process computer is used in conjunction with CRT units to provide a flexible monitoring system and dynamic adaptation to a process in operation.

12098 **Identification of selected control parameters for steam generators.** Bauer, B.; Unbehauen, H.; Nicolai, D. (Ruhr Univ, Bochum, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 7, 273-276(Jul 1977). (In German with English abstract).

Design criteria for optimal control systems of a steam generator are discussed. An analysis is made on the dynamic behavior of the whole plant. Three different approaches in selecting adequate parameters for control system are outlined.

12099 **Heating of evaporators in steam generators to saturation temperature.** Dolezal, R. (Tech Univ, Braunschweig, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 7, 281-286(Jul 1977). (In German with English abstract).

Methods for the most efficient heating in starting a steam generator with once-through flow systems are reviewed.

12100 **Erosion problems in steam turbines.** Krzyzanowski, J. (Inst Masz Przeplyw, Gdansk, Pol). *Brennst.-Waerme-Kraft;* **29**: No. 7, 286-290(Jul 1977). (In German with English abstract).

Research results concerning the erosion of blades in steam turbines are summarized. The effects of droplet structure on erosion rates are evaluated. An empirical formula is given for approximate determination of erosion rates.

12101 **Benson test route. Description and application of a 1-MW-high pressure cycle.** Hein, D.; Keil, H.; Koehler, W. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 6, 369-374(Jun 1977). (In German).

Larger unit capacities, increasing energy costs and varied methods of operation of modern steam generators require research and development aimed at reducing capital and operating costs, improvement of availability and suitability for enhanced operating requirements. The paper reports on an experimental plant, which in its design, covers the operating range which is of interest with Benson boilers.

12102 **Effects of feedwater treatment on boiler efficiency.** Hein, E.; Bunzel, D. *Energie;* **29**: No. 5, 153-158(May 1977). (In German).

The importance of proper feedwater treatment on total costs and efficiency of boiler operation is emphasized. Comparative data are given for different feedwaters showing the effects upon operational cost of boilers with and without treatment.

12103 **Implosions and explosions of furnaces.** Durant, O.W.; Lansing, E.G. *Arch. Energiewirtsch.;* **31**: No. 5, 397-420(May 1977). (In German).

In the past three years, considerable furnace damage has occured in several power plants because of excessive low gas-side pressure (or because of strong draft). These occurences have caused numerous investigations and opinions in manufacturing, building engineering, and public utilities circles. In this report, an investigation into the causes of this abnormal gas-side pressure behavior is described. Various measures for furnaces, fuel plants, regulation systems, equipment parts, and operation methods are recommended in order to lower the possibility of damage due to accidents caused by abnormal positive or negative gas-side pressure in furnaces.

12104 **700 MW bituminous coal power station unit Weiher III.** Spliethoff, H. *Energiewirtsch. Tagesfragen;* **27**: No. 4, 269-277(Apr 1977). (In German).

A brief description of the Weiher III 700 MW bituminous coal power station is presented. The following topics are discussed: position and site conditions, coal handling system, steam generator and firing furnace (with combined pulverized-coal/oil burners), cooling tower, and electrical and control systems. After 38 months of construction work, the unit started operation in September 1976.

12105 **Damage to a 680 MVA transformer results in extensive damage to a circuit breaker.** Kugler. *Maschinenschaden;* **50**: No. 1, 11-13(1977). (In German).

A 680 MVA unit transformer was damaged in the 500 MW unit of a large-scale steam power plant. The second unit of this power plant was to go into operation 2 1/2 years after the first one took up its service. Each of these two units, via a 21/425 kV unit transformer of the capacity mentioned above, feeds a 380 kV network of a public utility.

12106 Converter for starting gas-turbo-generators. Senger, K.; Wendt, D. *Tech. Mitt. AEG-Telefunken;* **67**: No. 1, 26-30(1977). (In German).

Today, start-up converters are counted among the largest converter units which are built for the supply of turbines with speed control. As an example of a standard model for the starting of gas-turbo-generators, the operation of these converters is presented. Simultaneously, it is shown which steps are taken for optimal use of the converters.

12107 Constant pressure stageDE9201483: of a steam turbine. Grohrock, O. (to Aktiengesellschaft Kuehnle, Kopp und Kausch, Frankenthal (Germany, F.R.)). German(FRG) Patent 2,526,029/A/. 23 Dec 1976. 9p. (In German).

A steam turbine with improved efficiency is described. Losses due to high relative flow velocities and repeated loading should be avoided. The improvement is achieved by the fact that the live steam nozzle is the driving nozzle of jet engine equipment, which sucks in the steam leaving the rotating blades, reduced by a part corresponding to the live steam quantity and taken to the waste steam ducts, and takes it back to the rotating blades together with live steam of suitable mixing speed.

12108 Sintered ceramic cores for hollow gas turbine engine blades. Landa, M.I.; Shpindler, S.S.; Portnoi, Ya.P.; Mamleev, R.F. *Russ. Cast. Prod. (Engl. Transl.);* No. 7, 281-282(Jul 1976).

These investigations have led to a commercial technique for the batch production of sintered ceramic cores based on α-Al_2O_3 with 5 per cent ZrO_2, for hollow GTE blades. The cores are fired for 5-10 h at 1150-1250°C and are loaded directly into a furnace at constant firing temperature. The addition of 1 to 3 % graphite and the development of hollow cores have overcome the problem of simultaneous mold and core removal. The cores are made from resin-bonded mixtures in semi-automatic machines.

12109 Longevity counter for steam turbines. Busse, L.; Parke, W. *BBC-Nachr.;* No. 9, 374-380(1976). (In German).

The number of the start-up and shutdown procedures of large steam turbines having an output of some hundred megawatts is increasing every day. This heating up and cooling down results in considerable stress. Compared with rated operation the longevity is shortened as a relation of frequency and extent of stressing. BBC has developed a concept for continuous supervision of the longevity of steam turbines.

12110 Adjusting drives for chemical and heat engineering. Hubler, P.; Poeschel, M. (Sulzer, Winterthur, Switz). *Chem.-Ing.-Tech.;* **47**: No. 12, 543-546(Jul 1975). (In German with English abstract).

The principal criteria affecting the choice of an adjusting drive are presented. Since a steam generator places great demands on control equipment, a comprehensive and specialized range of valves, drives, and control equipment has been developed for process control in thermal and nuclear power plants, and in industrial steam networks. It is important to take account of the wide range of operating conditions, such as explosion prevention, corrosive atmosphere, and radioactivity.

12111 Typical mechanical failures on large steam turbines in power plants. Boucheras, R. (Electr de Fr). *Rev. Fr. Mec.;* No. 52, 17-35(1974). (In French with English summary).

A survey of failures which occurred on shafts, blades and control valves on steam turbines in France is presented. Suggestions for design changes are made.

12112 Determination of the rupture life of gas turbine blades. Chaboche, J.L.; Stoltz, C. (Off Natl d'Etud et de Rech Aerosp, Fr). *Rev. Fr. Mec.;* No. 52, 37-47(1974). (In French with English summary).

Design criteria for turbine vanes and blades are reviewed with particular emphasis on cooling problems. A lifetime prediction method is described and evaluated. The applicability of the method in the design stage is demonstrated on an example for optimization of the film cooling of blades.

WASTE HEAT UTILIZATION

12113 Policy of improved resource utilization. Murgatroyd, W. (Imp Coll of Sci and Technol, London, Engl). *Energy Dig. (London) ;* **6**: No. 3, 12-14(Aug 1977).

In the United Kingdom, the Central Electricity Generating Board (CEGB) have published studies relating to the recovery and sale of heat rejected by modern large steam power stations. From these and other studies it seems clear that although there might be special circumstance in which this is attractive, in the great majority of cases there would be no saving of overall resources. it is the author's belief that the time has come to adopt a new policy in respect of energy utilization. We should examine the nation's requirements for heat, light and motive power as a whole and attempt to satisfy the joint need in the way which is most economic in resource use. One aspect of this--and it is only one of many--relates to the joint production of useful heat and electricity--sometimes called combined heat and power (CHP) or, in the US, co-generation. This suggests that we should discard the notion of the 'waste-heat' associated with electricity production and should, instead, and as a matter of policy, consider any local demand for heat as an opportunity to generate 'surplus electricity' which, if not required locally would be supplied to the national grid.

12114 Combined heat and power: a utility's view. Peddie, R.A. *Energy Dig. (London) ;* **6**: No. 3, 15-18(Aug 1977).

The Electricity Supply Industry (ESI) has sometimes been accused of being opposed to the principle of combined heat and power (CHP). It is useful, therefore, to have the opportunity to speak openly on this subject and to take part in the discussion. It is shown that steam-turbine plants have been developed to the point that there is no waste of heat at temperatures suitable for district heating (about 100$degree$C), the reject heat appearing as a very large flow of tepid condenser cooling water at about 20$degree$C. In a gas turbine power plant, however, exhaust gas is at a temperature suitable for heat recovery in a hot water boiler, without loss of electricity production. To run the gas turbines specially to produce heat at other times is costly because of their high fuel cost, and these costs would have to be recovered in the heat supply tariff. Nevertheless in some circumstances this may be the best option. The overall efficiency (i.e. allowing for losses in transmission and distribution) of the best CHP scheme was estimated at 65%, and that of the best boiler-only scheme at 51%. The ratio of heat/electricity production is estimated at about 4:1. On the basis that the electricity might alternatively have been produced by the CEGB at 30% efficiency it can be inferred that the CHP scheme would have saved about 30% of the fuel used by the boiler-only scheme. This saving was estimated at 27,000 tons coal equivalent per year--i.e. about 2$one quarter$ tons per household.

12115 Problems of power-heat-coupling in industry. *VIK (Ver. Ind. Kraftwirtsch.) Mitt.;* No. 1/2, 12-18(Mar 1977). (In German).

The coupled heat and electric power supply from counter-pressure and partly also from extraction-condensing plants theoretically offers the best possibilities for saving energy in comparison to other measures which reduce the primary energy employed at equal useful energy. A basic requirement for the use of this principle of power-heat coupling is a somewhat simultaneous need of heat and electrical energy as well as a relatively short distance between production point and consumption point, since the transfer ability of the heat is limited due to the considerable cost of the transportation system. Numerous industrial enterprises offer favorable conditions for the use of power-heat coupling. Because of the existing legal and contract rights restraints, the incentive for a free development of industrial power-heat coupling with the aim of saving energy is strongly weakened. Therefore a new order to road rights is nececessary, which would make possible the construction and operation of common plants for several industrial operations and which would insure the right to lay industrial energy lines in public roads where reasonably possible. It has been proven necessary to make it the duty of the cartel authorities to orient their examinations of price regulations for auxiliary and reserve electric power supply solely on the objective electricity economy facts, but not on so-called advantageous points of view. Ultimately the regulation for common use of the utilities own piping system for the purpose of saving and piping free energy and free power from its own plants can be reasonably necessary in the utilities realm, if free agreements between the utility and the industry are not enough in this question.

12116 Efficient use of energy by IC engines in stationary plants. *Klima Kaelte Ing.;* **4**: No. 10, 329-330(1976). (In German).

The use of internal combustion engines in a system for heating and power generation is discussed. Efficiency factors to be achieved in power-heat coupling are described. Utilization of waste heat for heating purposes is discussed. Operational experience with the Heidenheim heat and power generating station which covers 50% of the maximum heat demand in a housing estate with 283 dwelling units is discussed.

ECONOMICS

REFER ALSO TO CITATION(S) 12274, 12631

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 11931, 12560, 12634

FUELS

12117 Vorschlag einer Verordnung des Rates ueber finanzielle Massnahmen der Gemeinschaft zur Foerderung des Kohleeinsatzes fuer die Stromerzeugung. Beschlussempfehlung und Bericht des Auss-

chusses fuer Wirtschaft (9. Ausschuss) zu der Unterrichtung durch die Bundesregierung. (Proposal of an ordinance of the Council on financial measures of the Community for promoting the use of coal for power generation. Resolution recommendation and report of the Committee on Economics (9th Committee) concerning the information by the Federal Government). Bonn, Germany, F.R.; Bundestag (27 May 1977). 3p. (In German).

The EC Commission sees the necessity to maintain and to extend the capacities of coal power stations in the Community. Despite endorsing the aim of the energy policies, the ordinance was rejected in its present form. Alternatives are proposed to promote power stations only if EC coal is used and to improve the instrumentation accordingly. The costs are met out of the EC budget.

12118 Composition of fuel for gas turbines. Scott, J.F. (to Perolin Co., Inc., Wilton, Conn. (USA)). German(FRG) Patent 2,365,763/A/. 8 Jul 1976. 15p. (In German).

The fuel composition upon which the invention is based permits gas turbine operation at high temperatures with the danger of corrosion considerably reduced, even with combustion air containing sea salt. To the fuel oil, containing vanadium and/or alkali metal as impurities, substances consisting mainly of silicon and magnesium compounds are added which result in MgO and SiO_2 during fuel combustion, whereby the weight ratio SiO_2 : MgO should be greater than 2 : 1, and on each vanadium proportion by weight in the fuel are to fall at least 2 magnesium weight proportions, and on every alkali metal proportion by weight at least 2 silicon weight proportions. With regard to an environment which lets sea salts into the air for combustion, the amount of substances to be added has to be calculated in such a way that at least 2 but preferably 6 silicon proportions by weight fall to every alkali metal weight proportion contained in the combustion products for gas turbines.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 13170

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 12417

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 11490

12119 Flue gas-side-cleaning of oil-fired boilers at Harburg power station. Sperling, E. (Hamburgische Electricitaets-Werke A.G. (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 6, 392-399(Jun 1977). (In German).

The boilers fired by heavy residual oil in Hamburg Electricity Undertaking's (HEW) Harburg Power Station are cleaned by soot blowing during operation and by washing with river water after an average of 2500 hours operation. The neutralized purge water, decanted, is conducted back to the surface water. The residual slurry is deposited, in accordance with official regulations, in a public waste disposal area.

12120 Estimation of the dust content in waste gas on account of the reading on a smoke density measuring device. Brand, E.; Geipel, W. *Waerme;* **83**: No. 2/3, 32-34(Jun 1977). (In German).

An optical smoke density measuring device was operated on a semi-technical experimental plant. On the basis of the results it is shown how dust accumulation can be estimated if the characteristic particle size of flue dust is known. The limitations which were made are discussed.

12121 Local and temporal distribution of dust profiles in flue gases of large steam boilers. Buehne, K.W.; Jockel, W. *Staub-Reinhalt. Luft;* **37**: No. 5, 189-194(May 1977). (In German).

For the installation of power plants with emission monitoring systems it is in some cases not sufficient to know only the mean value across the area of the dust load. To get more information about the local and temporal distribution of the dust profiles, detailed measurements were made in the flue gases of seven coal-fired boilers. In the field tests simultaneously different emission monitoring systems were used. These data are compared for calibration with the gravimetric determination of dust load. All results are discussed and some hints are given to suitable installation places for monitoring systems.

12122 Gas scrubbing liquids. Lackey, W.J.; Lowrie, R.S.; Sease, J.D. (to Department of Energy). US Patent Application 761,037. 21 Jan 1977. 8p.

Various systems and techniques have been devised for reducing or elimiinating the noxious contaminants produced as by-products of industrial processes. Of particular interest are the contaminants which are released to the atmosphere as a result of combustion. These contaminants are of the type which are normally released from a stack in the form of what is normally referred to as smoke. Smoke, depending upon its source, may contain suspended particulates, hydrocarbon vapors, soot, and aerosols. A description is given of the use of fully chlorinated and/or fluorinated hydrocarbons as gas scrubbing liquids for preventing noxious gas emissions to the atmosphere.

12123 Steam boiler fired with solid fuel and fly-ash recovery. Eilers, F. (to Chemische Werke Huels A.G., Marl (Germany, F.R.)). German(FRG) Patent 2,525,745/A/. 16 Dec 1976. 9p. (In German).

The invention concerns a steam boiler with solid fuel firing, dust extractors and fly ash recovery. There is also a molten ash chamber with slag extraction at the combustion chamber. In order to reduce the filter loading of the plant by fly ash, a fly ash nozzle is provided which blows the fly ash into the molten surface with an acute angle of 20-45°. Due to this construction there is the possibility of compressing the fly ash when blowing into the surface of the melt and thus binding it appreciably better than previously and bringing it to the melt.

SITE SELECTION AND LAND USE

REFER ALSO TO CITATION(S) 12273, 12631

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 12632

12124 Harmonisierung der Starkstromkabel und -leitungen. (Harmonizing power cables and power lines). Heinhold, L. (Siemens A.G., Erlangen (Germany, F.R.)); Retzlaff, E.; Warner, A. (Verband Deutscher Elektrotechniker (VDE) e.V., Frankfurt am Main (Germany, F.R.)). Berlin, Germany F.R.; VDE-Verl. (1976). 48p. (In German).

The article gives a summarizing view of the present level of harmonization in the field of power cables and lines. Special attention is paid to problems referring to using harmonized designs for flexible lines and using lines for solid layout with PVC and rubber insulation in the German standards DIN 57281/VDE 0281 and DIN 57282/VDE 0282 and problems of taking the types used until today out of use. A general view of the power lines fully harmonized is given and a harmonization-labelling (common labelling) for cables and lines is described.

12125 (DOE-tr—2) Electrical high power transmission and distribution in congested areas. Jun 1977. Translation of BMFT-ET—4042A. 217p. Dep. NTIS, PC A10/MF A01.

This study was initiated by the Ministery for Research and Technology in the Federal Republic of Germany to assess future developments in electrical power supply and to provide decision aids for judging the worth and need of innovative operating equipment for electric power transmission. This study concentrates on the transmission in congested areas of large amounts of electric power over relatively short distances. Of primary consideration are future load development, the physical and technical capabilities of different transmission technologies, e.g., ac and dc systems, overhead and underground transmission, the economic aspects of installing and operating different transmission systems, and the environmental impact. From this study it was concluded that overhead transmission is cheaper and more reliable than underground. The latter is recommended only where it is unavoidable due to dense developments. It is also concluded that development priority be given to improving the transmission capabilities of overhead lines and to improving forced-cooled underground cables for EHV AC systems. (LCL)

12126 Optimal decentralized regulators for load frequency control. II. Load disturbance rejecting regulators synthesis. Popeea, C.; Cautis, D. (Polytech Inst of Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 271-276(1977).

A new procedure for synthesizing decentralized load disturbance rejecting regulators in interconnected power systems is presented. It is shown that, by using the proposed procedure, some very convenient closed-loop properties are obtained.

12127 Method to produce water-cooled high-power cables. Friesenhagen, E.; Rasquin, W.; Schwerdtfeger, O. (to Felten und Guilleaume Kabelwerke A.G., Koeln (Germany, F.R.)). German(FRG) Patent 2,334,430/C/. 25 Nov 1976. 2p. (In German).

A production process for water-cooled high-power cables is described. These consist of the inner conductor with closed hollow duct, a paper insulation, an outer electrical shielding and the jacket tube. As the diameter of the cable core must be 150 to 200 mm for the intended transmission power of more than 2,000 MVA, the existing impregnation and insulation systems cannot be used. They

can be dispensed with if, according to the invention, the jacket tube is first sealed vacuum tight and then evacuated while hot steam is led through the inner conductor at the same time. After the insulation has thus been dried, it is impregnated with insulating oil which is led into the jacket tube.

12128 Electric cable, preferably high-voltage cable. Arendt, I.; Lemmerich, J.; Lukaschewitsch, A. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,139,599/B/. 18 Nov 1976. 6p. (In German).

An electric cable, preferably a high-voltage cable, whose insulation consists of an olefine polymerisate, is described. This is an ethylene-based polymerisate or copolymerisate to which, according to the invention, 0.1 to 2% tetraalkyl-diamino-diaryl-alkane is added to increase the electrical strength. A very suitable tetraalkyl-diamino-diaryl-alkane is N,N,N',N'-tetramethylene-diamino-diphenylmethane. Furthermore, the cable insulation contains small additions of an antioxidant.

12129 Measuring arrangement for currents in a high voltage conductor. Kohler, W. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,428,906/A/. 2 Jan 1976. 11p. (In German).

The invention concerns a measuring arrangement for currents in a high-voltage conductor. The high-voltage conductor contains a resistor, at which a voltage proportional to the current arises. This voltage is used to form a corresponding frequency by a voltage-to-frequency converter, and is applied via a high-voltage side. Here one obtains a potential at low voltage, whose frequency is a measure of the current in the higher voltage conductor by its frequency. It can be evaluated directly or converted by a frequency-to-voltage converter into an analog parameter. The voltage-to-frequency converter on the high voltage side obtains its operating voltage via a capacitative voltage divider and a rectifier. As this operating voltage would fail if the high voltage conductor were at zero voltage, there is a second resistor in the high voltage conductor, which ensures the operating voltage supply of the converter via a rectifier.

12130 Water-cooled high voltage power cable. Rasquin, W.; Suetterlin, K. (to Felten und Guilleaume Kabelwerke A.G., Koeln (Germany, F.R.)). German(FRG) Patent 2,307,013/B/. 7 Aug 1975. 5p. (In German).

The invention concerns a water-cooled high voltage cable for the transmission of 2000 MVA or more. It consists of a cylindrical electrical conductor with the internal hollow channel which takes the coolant, between the insulation surrounding the conductor and the outer cable sheath. The diameter of the hollow channel is at least 60 mm for aluminum conductors, and at least 70 mm for copper conductors. If aluminium is used the wall thickness of the conductor is 15 mm, for copper it is 12.5 mm. The electrical insulation is oiled paper or plastic material.

12131 Front solution program for transmission tower analysis. Natarajan, R. (Indian Inst Technol, New Delhi). *Comput. Struct.;* **5**: No. 1, 59-64(Apr 1975).

A simpler version of the frontal solution technique suitable for solving structures with large numbers of members is described. The facilities of the program are brought out with regard to the resolution and re-design of a large structural problem. It is used to solve a transmission tower problem. The resulting stress distribution in the main members are discussed.

12132 Electric insulation for high voltage windings, especially for electrical machines. Jagusch, W.; Schindelmeiser, F.; Saure, M. (to AEG Isolier- und Kunststoff G.m.b.H., Kassel (Germany, F.R.); Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 2,206,528/C/. 24 Oct 1974. 2p. (In German).

The invention relates to a mica base electric insulation for high voltage windings, especially for thermal class F electrical machines, which is resistant to surface leakage currents and can be attached void-free as pre-impregnated broad foils or strips at room temperature to prestabilized or non-prestabilized bunched conductors by very simple tools. In the invention, an uncalcined fine mica foil of a minimum weight of 250 g per sq.m. is used which, together with a carrier of woven cloth or fleece material, has a minimum weight of 400 g per sq.m. after impregnation with a binder. The binder is a resin mixture of a cyclo-aliphatic acetal base epoxy resin with a viscosity of 1100 +- 500 cP at 120°C, a cyclo-aliphatic carboxylate base epoxy resin of a viscosity of 800 cP at 20°C, and a hardener on the basis of BF_3 amine adducts.

AC SYSTEMS, EHV AND UHV

REFER ALSO TO CITATION(S) 11816

12133 (CONS/2057—1) Development of an improved extruded dielectric cable rated 230 kV. Blais, L.D.; Traut, R.T.; Bolden, G.N. (Kaiser Aluminum and Chemical Corp., Portsmouth, R.I. (USA)). May 1977. Contract EC-76-C-01-2057. 198p. Dep. NTIS, PC A09/MF A01.

Work performed on developing an improved 230 kV extruded solid dielectric cable, the techniques of jointing such cables and the testing of terminations suitable for operation at that voltage level are described. Difficulties were encountered during manufacture in applying the semi-conducting extruded conductor shield. A new higher melt point compound solved the problem. A joint capable of operating at the 230 kV level was developed but showed a deficiency under voltage impulse testing while the conductor was at elevated temperature. A reduction in contract scope terminated this effort. Two terminals rated for 230 kV were found to be commercially available from domestic manufacturers. The limited testing performed showed them to be compatible with the cable cross-linked polyethylene insulation and electrically sound under 60 Hertz testing. No direct voltage or impulse voltage testing was performed on the terminations. A sample circuit, consisting of cable and joint, was subjected to impulse voltages at both room temperature and normal conductor operating temperature of 90°C. While the cable only was able to withstand voltage impulses in excess of the Basic Impulse Level (BIL) at room temperature, it failed at BIL while conductor was heated to 90°C. In like manner, a cable and joint circuit was assembled. Similar voltages were impressed at room temperature without incident. The joint failed at 90°C conductor temperature. Cable, joint and termination were assembled in a simulated circuit and subjected to conductor loading to elevate temperature while 60 Hz voltages in excess of normal operating levels were continuously applied.

12134 (EPRI-EL—532) Feasibility and viability study of an air cooled, foam-insulated transmission system. Final report. Greenwood, A.; Anderson, J.; Singh, N. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA); General Electric Co., Pittsfield, Mass. (USA)). Apr 1977. 118p. Dep. NTIS, PC A06/MF A01.

An analytical investigation of the technical feasibility and economic viability of a novel underground power transmission system is described. The current-carrying conductors of the system are relatively large diameter, thin walled aluminum tubes, which are mechanically supported and electrically insulated from each other and from ground by a closed cell, polyurethane foam. The transmission line is cooled by passing ambient air through the pipes between blower and exhaust stations at intervals along its length. A preliminary design for such a line is developed, taking advantage of the opportunities for trade-offs between electrical, thermal and mechanical requirements. This design is costed and compared with two existing technologies, HPOF cable and CGI bus. There appear to be no clearly insurmountable difficulties in the way of developing an underground foam-insulated (UGF) line. The system has the potential of being a low capacitance, high ampacity alternative for EHV transmission circuits of the order of 100 miles in length, particularly in rural and semi-rural areas, where overhead lines are unacceptable; typical ratings are 1400 MVA at 345 kV and 4500 MVA at 550 kV. Based on preliminary designs, the economics look attractive. Environmentally, it would be a good neighbor. Insulation and cooling are the most influential factors of the system. Specific recommendations are made for further evaluating the concept.

12135 (EPRI-EL—575) Guide to the design and general use of the Waltz Mill Forced Cooling Research Facility. Final report. Purnhagen, D.W. (Jerome Underground Transmission Equipment, Inc., Commack, N.Y. (USA)). Sep 1977. Contract EX-76-C-01-1607. 224p. Dep. NTIS, PC A10/MF A01.

The 138 kV Forced Cooling Test Facility at Waltz Mill is described in detail. Design information for system components as well as operational and maintenance procedures are given. Of significant interest is the design and construction of the cable itself which represents a major stride forward in the ability to instrument high voltage cables. Results of preliminary testing characterizing thermal/hydraulic behavior are also presented. Forced cooling friction loss data for a known cable configuration has been successfully correlated to model studies. Cable characteristics such as insulation thermal resistivity and AC loss data are also supplied.

12136 Digital simulation of unsymmetric unbalances on three-phase power networks using new frame sequence components. Chhalotra, G.P.; Bhat, B.K.; Chourasia, M.P. (Government Engineering College, Jabalpur, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **57**: No. 6, 247-256(Jun 1977).

The analysis of power system problems at unbalances is analyzed using new sequence components on a digital computer. The analysis of unsymmetric unbalances, with phase-A as the reference, is simplified on the digital computer when lambda μ 0 and rho sigma 0 components are used. The components form a powerful tool on the digital computers due to decoupling of sequence networks in the various fault situations. The components are recommended for the analysis of unsymmetric unbalances on a digital computer when the power system is very large.

12137 Importance of epoxy-bonded transposed cable for large power transformer windings. Babare, A. (Lab Chim-Fis dell'Itraltrafo, Napoli, Italy). *Elettrotecnica;* **64**: No. 3, 193-206(Mar 1977). (In Italian).

The radial electromagnetic forces in large core-type transformers, with uniform concentric windings are examined. After having pointed out some fundamental principles, the paper examines the behavior of outer windings, such as disk, and of inner windings, such as helical, subjected to short circuit stresses. The importance of the width of bare strand for the buckling strength of inner windings and, consequently, the importance of hard drawn epoxy bonded transposed cable in their construction is pointed out. In addition, particular emphasis is placed on some aspects of use of epoxy resin defining the characteristics that the latter must possess, the factors influencing the cementation of the strands, mechanical characteristics obtainable and durability.

12138 Transformers: thoughts on the future of a traditional product. Preininger, G. (Elin-Union, Vienna, Austria). *Elin-Z.;* **29**: No. 3, 78-83(1977). (In German).

After a brief report on present-day transformer production, trends and tendencies of further development are discussed. It is concluded that the spectacular rise of rating per unit as experienced in the past can hardly be expected to continue in the years ahead.

12139 Computer program for the layout and optimization of power-type and medium transformers. Buol, S. *Elin-Z.;* **29**: No. 3, 100-106(1977). (In German).

The article describes a computer program for optimizing the design of the mains, medium, and dry transformers. For description, a method of "hierarhical documentation" is used, which has proved to be efficient and time saving.

12140 How to design a rain installation for dielectric tests of hv and ehv switchgear. Gallet, G. (Electr de Fr). *Bull. Dir. Etud. Rech., Ser. B;* No. 3-4, 21-28(1976). (In French).

The paper presents the method used for the design of a rain apparatus necessary for dielectric tests of the equipment for HV and UHV networks. An example of this method is used on an apparatus for the UHV Laboratory at Renardieres.

12141 Contribution to the study of electrochemical water-treeing in polyethylene for hv cables. Fournie, R.; Perret, J.; Recoupe, P. (Electr de Fr). *Bull. Dir. Etud. Rech., Ser. B;* No. 3-4, 29-47(1976). (In French).

Penetration of water in cable insulations made with synthetic materials can lead to the formation and growth of water-treeing. Among many factors affecting the water-treeing formation in synthetic materials, those more directly concerned in the technology of cables are preferably studied. Tests with three types of solutions (demineralized water, saturated solution of NaCl, and NaCl solution with concentration of 100 g/l) and aluminum, copper, and lead electrodes with 10,000 V current, 50 Hz, for up to 2000 hr are described.

12142 Modern power cables ensuring reliable and economic transmission of electrical energy. Bax, H. *Oesterr. Z. Elektrizitaetswirtsch.;* **28**: No. 8, 426-432(Aug 1975). (In German).

The present situation regarding power cables and the structure of the networks of the electricity supply undertakings are discussed in detail. Starting with the paper-insulated cables which had proved useful for several decades, the report describes the change-over to plastic-covered cables during the last few years. The steadily growing degree of electrification will call for much larger capacities in future transmission facilities than have been available so far. Interesting new power transmission facilities already in use or in the stage of development are treated in detail. Expected transmission capacitites are presented.

12143 Underground distribution systems in urban areas of high consumption density. Lemoine, J.C. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 6, 430-432(Jun 1975). (In French).

This short paper gives some basic ideas on the design of power distribution systems for towns, more particularly for new towns.

12144 Electric power supply to large urban centers--2. v.h.v. distribution in large urban centers. Rollin, J.; Calmon, J.; Rouyer, J.P. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 5, 402-408(May 1975). (In French with English abstract).

The first part of the article is devoted to the review of those basic structural principles of the networks adopted for long-term planning of power distribution in large urban centers. The second part of the article concerns itself with the 225 kV works and equipment used in the construction of these systems. In conclusion the distribution system for the new town of Saint-Quentin-en-Yvelines is described.

12145 Best location and percentage series compensation of long transmission line for maximum power transfer. Krishna Prasad, M.T.; Thapar, B. (Punjab Eng Coll, Chandigarh, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **55**: 147-150(4 Apr 1975).

For long distance transmission of large block of power, series compensation is the best available method of improving the transmission capability of a line. Series compensation may be provided as lumped or distributed. The effect of sending-end to receiving-end voltage ratio on the location of series compensation for maximum power transfer is considered. Determination of the best location and percentage series compensation for maximum power transfer in a transmission line of nearly 1000 km length, is discussed with the help of generalized curves.

12146 Technico-economic effectiveness of lowering test voltages of extrahigh-voltage transformers. Shifrin, L.N.; Frenkel', V.Yu.; Nosachev, V.A. *Elektrotekhnika;* No. 4, 1-4(Apr 1975). (In Russian).

Calculations show that lowering test voltages in 330--750 kV transformers yields a significant technico-economic effect. For each 10% of test voltage lowered, transformer costs are reduced by 4 to 8%, the full mass by 4 to 7%, idling losses by 3.5 to 5%, economic expenditure by 2 to 3%, and maximum capacities are increased by 6 to 8%.

12147 Determination of power transmission requirements to be assured by a ehv system. Clade, J.; Persoz, H.; Pouget, J. (Electr de Fr). *Rev. Gen. Electr.;* **84**: No. 4, 285-293(Apr 1975). (In French with English abstract).

In an attempt to define the transport and interconnection functions of an EHV system, the authors present a method leading to a more accurate definition of the power transit requirements this system has to cope with. This can be valuable in its planning.

12148 Insulated overhead aluminum cables: new techniques for low voltage distribution networks. Gentili, S.; Salamini, O. *Alluminio;* **44**: No. 2, 76-80(Feb 1975). (In Italian).

A comparison is made between the new systems with an aluminum-alloy messenger cable and the old systems (insulated aerial cables and bare overhead conductors). Technical and economic problems are considered. Particular suitability of these cables for rural electrification is stressed.

12149 High voltage znr surge absorber. Matsuoka, M.; Eda, K.; Kuchiba, K.; Masuyama, T.; Nishigori, A. (Wireless Res Lab, Jpn). *Natl. Tech. Rep. (Matsushita Electr. Ind. Co., Osaka);* **21**: No. 1, 109-122(Feb 1975). (In Japanese).

This paper describes high-voltage "ZNR" surge absorbers for protection from switching surges of vacuum switches in 3300 and 6600 V ac lines. The new products are based on an improvement in the electrical properties and structure of "ZNR" surge absorbers for 100 to 400 V ac lines. High voltage "ZNR" surge absorbers are characterized by many features, such as a low residual voltage, a quick response, a large capability for surge current, and a small size, and they are provided with additional functions of a self-indicator for deterioration and a circuit breaker. They can be used widely for various industrial equipments. The electrical characteristics, structure, reliability and applications of these devices are discussed.

12150 Precise sags and tensions in multiple span transmission lines. Barrien, J. (Electr Trust of S Aust). *Electr. Eng. Trans., Inst. Eng., Aust.;* **EE**: No. 1, 6-11(1975).

The development of appropriate hyperbolic formulae and an iterative computer program are described, which enables a mathematically correct evaluation to be made of tensions, sags and deflections in transmission line conductors. The method takes into account the actual movements of each insulator string, and elastic movements of structures. Provision is made to allow for varying ambient conditions, span to span, alteration to conductor lengths in any span, breakage of conductor in any span, alteration of support positions, weights on conductors at any point, removal of existing supports and insertion of new supports. Apart from the facility which the program provides of enabling solutions to otherwise difficult problems, some significant discrepancies are revealed compared with the traditional "equivalent span" method, particularly with lines having large differences in elevations and span lengths. 4 refs.

12151 Shipment and assembly of large transformers and inspection on the site. Fanftl, H. (Werkes Weiz). *Elin-Z.;* **29**: No. 3, 91-95(1977). (In German).

A short summary of precautions to be taken prior to shipment of transformers and after arrival of the units at the site with the object not to impair their operational reliability is given.

DC SYSTEMS

REFER ALSO TO CITATION(S) 21000012567

12152 Design of optimal regulators for parallel ac-dc power systems. Dash, P.K.; Puthal, B. (Reg Eng Coll, Rourkela, India). *J. Inst. Eng. (India), Electr. Eng. Div.;* **55**: 151-155(4 Apr 1975).

The procedure for synthesising an optimal controller for small perturbations, subject to a quadratic performance index, together with a set of eigenvalues for a HVDC power system, is presented. The performance of the system with this controller is compared with dc link current reference controller fed by the first and second derivative signal proportional to either deviation of the terminal voltage or the load angle or a combination of both. The optimal controller extends the stable operating region of the system at low active power levels, increases the magnitude of perturbations for which the actual nonlinear system is stable and improves the transient response of the system. The choice of Q and R matrices for the system is made by a recursive procedure by shifting the eigenvalues to desired regions and minimizing the performance index at the same time. Also the solution of optimal control law is done with the help of real matrices which are easily dealt with by small computers like IBM 1130 by using certain transformation matrices for the complex eigenvalues and eigenvectors of the Hamiltonian of the system. The digital computer runs showing the transient response of a typical ac-dc power system, are presented highlighting the usefulness of this type of controller.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

12153 Electrical connection between a cryogenic and a normal-conducting cable. Scheffler, E.; Ziemek, G. (to Kabel- und Metallwerke Gutehoffnungshuette A.G., Hannover (Germany, F.R.)). German(FRG) Patent 2,519,798/A/. 18 Nov 1976. 7p. (In German).

An electrical connection at a branching or connection point between an electrical cryogenic cable and a normal-conducting cable is described. According to the invention the bare conductor of the cryogenic cable is surrounded at the connection point by mercury into which reach the bare ends of the normal conducting cable. Those parts of the cryogenic cable which are in touch with the liquid metal are activated by an additional layer of copper from 3 to 10 μ.

NUCLEAR POWER PLANTS

12154 (IBK—1405) Research connected with nuclear power plant construction in Technical Research Center of Finland. Marinkvovici, N. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1977. 23p. (In Serbian). Dep. NTIS (US Sales Only), PC A02/MF A01.

This report is result of a month spent in the Nuclear Engineering Laboratory of the Technical Research Center of Finland. Since Finland is an interesting country from the point of introducing nuclear power, the main subjects of this report are the problems of fuel management, burn up, safety analysis fuel cost optimization as they are treated in the mentioned Laboratory in connection with the first Finnish nuclear power plant Lovisa.

12155 (Juel-Conf—23) Nuclear energy applications other than electricity production. Reents, H.; Eich, P. (eds). (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Dec 1976. vp. (AED-Conf—76-733-000; CONF-7604129—). NTIS.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

Each paper has been separately processed for the Energy Data Base. (DG)

12156 (MRR—160, pp 21-37) Estimation of the void-reactivity coefficient in a BWR. Rao, H.S.; Frogner, B. (Systems Control, Inc., Palo Alto, Calif. (USA)); Carmichael, L.A. (General Electric Co., San Jose, Calif. (USA)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

This paper discusses a method for estimating the void-reactivity coefficient in a boiling water reactor. The method is based on a maximum likelihood approach combined with a Kalman filter for state estimation. Results are presented for an off-line application of the method to BWR data. Modifications for on-line and diagnostic analysis are discussed in the paper.

12157 Evolution of nuclear programs in the world. Prospects and perplexity. Gaussens, Jacques (Institut National des Sciences et Techniques Nucleaires (INSTN), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). *Rev. Gen. Nucl.;* No. 1, 9-29(1977). (In French).

Since 1975, a collapse in the rate of ordering new nuclear power stations is noted in the United States and, a less-accentuated recession, although evident in the rest of the world. Will this crisis last. Is it a conjunctural or structural accident. An attempt is made to answer this question by analyzing, mainly in the United States and France, the behavior of the main economic items concerned: electric current producers, manufacturers, and administration (in association with their specific public opinion).

12158 Operational experience with nuclear power stations in the Federal Republic of Germany. *At. Strom;* **21**: No. 5-6, 33-58(May-Jun 1975). (In German with English abstract).

A comprehensive review of experiences with operating nuclear power installations in the FRG during 1974 is presented.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 11785, 12440, 12443, 12444, 12450, 12459, 12463, 12467, 12470, 12471, 12490

12159 (BNWL—2091) Method for determining the uncertainty of gap conductance deduced from measured fuel centerline temperatures. Hann, C.R.; Lanning, D.D.; Marshall, R.K.; Olsen, A.R.; Williford, R.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1977. Contract EY-76-C-06-1830. 80p. Dep. NTIS, PC A05/MF A01.

The paper describes the method which was developed to determine the uncertainties of gap conductances deduced from measured fuel centerline temperatures of NRC-RSR/BPNL fuel rods irradiated in the Halden Boiling Water Reactor. The $\int k(t)dt$ method is used to calculate the fuel surface temperature from the measured fuel centerline temperature and the fuel thermal conductivity. The gap conductance is calculated from the fuel surface temperature, the calculated cladding inside surface temperature, and the measured fuel assembly power. The uncertainties in the input parameters for calculating the gap conductance were established and the uncertainty in the gap conductance was calculated using the method of propagation of uncertainties with a first order Taylor series approximation to the nonlinear functions. An example of the calculational method is given.

12160 (BNWL—2285) Effects of fill gas composition and pellet eccentricity. Williford, R.E.; Hann, C.R. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1977. Contract EY-76-C-06-1830. 38p. Dep. NTIS, PC A03/MF A01.

Data and an analysis are presented showing that when the operating pellet-cladding gap size of contemporary UO_2 fuel rods is carefully considered, the gap conductances are closely proportional to the thermal conductivities of the fill gases. Pellet-cladding gap eccentricity is shown to raise the gap conductance appreciably in cases of high thermal gradients across the gap. Ignoring the azimuthal heat flow can lead to an underestimation of the thermal time constant of the rod, resulting in a slower calculated thermal response during power transients. The data for this report were obtained during the startup of the NRC-RSR/BPNL test assembly IFA-431 in the Halden Boiling Water Reactor in Norway.

12161 (CNEN-RT/ING—76-13) Corrosion in water moderated nuclear power plants. Conte, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1976. 18p. (In Italian). Dep. NTIS (US Sales Only), PC A02/MF A01.

In this report the main problems connected to corrosion failures of the structural materials of water cooled nuclear reactors are described.

12162 (GKSS—77/E/16) Cost of the fuel cycle of nuclear reactors. Jager, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.)). 1977. 101p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

The nuclear fuel cycle of LWRs is described, and the method for calculating the proportion of costs for energy generation caused by the fuel cycle are discussed. Illustrated by the example of the ship reactor EFDR-80, the nuclear fuel cycle costs are calculated taking as a basis up-to-date economic data. The contribution was concluded in September 1976.

12163 (MRR—160, pp 53-76) Neutron noise analysis of BWR using time series analysis. Fukunishi, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and sutomatic control.

The main purpose is to give a more quantitative understanding of noise sources in the neutron flux and to provide a useful tool

for the detection and diagnosis anomalous reactor operation. The space dependent effects of distributed neutron flux signals at the axial direction of two different strings are investigated by the power contribution ratio among neutron fluxes and the incoherent noise spectra of neutron fluxes derived from autoregressive spectra. The signals are measured on the medium sized commercial BWR of 460 MWe in Japan. From the obtained results, local and global noise sources in neutron flux are discussed.

12164 (NUREG—0030-77/9) **Nuclear power plants. Construction status report, data as of August 31, 1977.** (Nuclear Regulatory Commission, Washington, D.C. (USA)). Sep 1977. vp. NTIS $10.00.

This management report is designed to provide the necessary information for monitoring the progress of construction of nuclear power plants. It provides data for synchronizing the licensing process with predicted fuel loading dates, as well as providing a central federal government report for commercial reactor construction. It utilizes data collected from the utilities sponsoring these projects and the Office of Inspection and Enforcement, NRC, and analyzed by the Office of Management Information and Program Control in the implementation of Management Information Systems. The status of the 93 plants authorized to engage in construction activities in Regions I thru V is summarized in this document. This total includes (4) plants with construction exemptions, and (11) plants with Limited Work Authorization Permits.

12165 (ORNL/TM—6008) **Projections of spent fuel to be discharged by the U.S. nuclear power industry.** Alexander, C.W.; Kee, C.W.; Croff, A.G.; Blomeke, J.O. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 85p. Dep. NTIS, PC A05/MF A01.

Calculated properties of spent fuel projected to be discharged and accumulated by the U.S. nuclear power industry through the year 2031 A.D. are presented. The projections are based on installed nuclear capacities of 380 and 543 GW(e) in the year 2000 and 2030, respectively. They include compilations of the grams of the elements, curies of radioactivity, thermal decay power, photon and neutron emission rates, and radiotoxicities of the assemblies that are accumulated at a Spent Unreprocessed Fuel Facility (SURFF), allowing for delays of 5 and 10 years before shipment to SURFF.

12166 (RISO-M—1946) **Power correlations for fuel menagement studies in LWR's.** Petersen, T. (Risoe National Lab., Roskilde (Denmark)). Jul 1977. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

In multicycle fuel management studies, a certain knowledge of the power distribution between different fuel types is required. This has to be calculated without detailed information on the position of the fuel in the core. Simple correlations to fulfil this requirement are suggested for both PWRs and BWRs.

12167 **Sealing boric acid solutions with mechanical seals in nuclear service.** Kanasaki, S.; Schoenherr, K. (John Crane Jpn, Inc, Osaka). *Lubr. Eng.;* **33**: No. 8, 417-418, 427-432(Aug 1977).

The sealing of borated water with mechanical seals in safety-related auxiliary pumps of light water nuclear reactors requires special consideration with regard to design and material selection. Results of extensive testing and evaluation of mechanical seals in 2% and 12% boric acid solutions in water are presented which show that at elevated temperatures 12% boric acid becomes highly corrosive, which has led to a search for a suitable material for the wearing faces of the seals. 3 refs.

12168 **Heat insulation works for nuclear power plant pipings.** Kishi, T. (Nippon Asbestos Co. Ltd., Tokyo). *Haikan Gijutsu;*, **18**: No. 13, 160-166(Nov 1976). (In Japanese).

As the conditions for the heat insulation works required for nuclear power plants, the article coping with the effect of being exposed to radiation is added to those required for thermal power plants. The heat insulation works for nuclear power plant pipings mean those within reactor containment vessels. The conditions required under radiation are the stability of used materials to radiation, the considerations to cleansing spray and the decontamination of radioactivity, and the disposal of heat-insulating materials at the time of periodical inspection. A large amount of austenitic stainless steel is used for nuclear power plant pipings, therefore the measures to stress corrosion cracking are required. So far, the unified prescription has not been established for the solution of these problems, because the materials used are diversified, and the unified prescription may be sometimes an obstacle. The description hereinafter is concerned with light water reactor plants. The fundamental principles are shown in JIS A 9501-1974 "Standard for practising heat insulation works". Heat-insulating materials must be kept in dry state. Prior to attach heat-insulating materials, dust, rust, grease and other foreign substances must be completely removed from the surfaces of pipes. The practices of fixed and movable heat insulation are explained. The conditions for designing the thickness of heat-insulating layers are shown.

12169 **Statistical operation of nuclear power plants.** Gauzit, M. (Alsthom, 75 - Paris (France)); Wilmart, Y. (Novatome Industries, 92 - Le Plessis-Robinson (France)). *Rev. Gen. Nucl.;* No. 3, 236-248(1976). (In French).

A comparison of the statistical operating results of nuclear power stations as issued in the literature shows that the values given for availability and the load factor often differ considerably from each other. This may be due to different definitions given to these terms or even to a poor translation from one language into another. A critical analysis of these terms as well as the choice of a parameter from which it is possible to have a quantitative idea of the actual quality of the operation obtained is proposed. The second section gives, on an homogenous basis and from the results supplied by 83 nuclear power stations now in operation, a statistical analysis of their operating results: in particular, the two light water lines, during 1975, as well as the evolution in terms of age, of the units or the starting conditions of the units during their first two operating years. Test values thus obtained are compared also to those taken 'a priori' as hypothesis in some economic studies.

12170 **Guide for acquisition and documentation of reference power reactor physics measurements for nuclear analysis verification.** Chicago; American Nuclear Society (1976). 19p.

It is the purpose of this Standard to specify criteria for performing and documenting measurements on light water power reactors which are to be used as reference measurements in the validation of reactor physics computational methods. Considerably more confidence is placed in nuclear analysis methods when they have been successfully used to calculate performance characteristics that have been carefully measured in an actual operating system. The existence of well-documented measurements made in a number of operating power reactors will fill a need on the part of the nuclear designer and reactor operator, and will permit the development of increased confidence in the design and performance analysis methods used to predict reactor performance. This Standard is not a guide for routine measurement of reactor physics parameters in an operating reactor. The objective of routine measurements carried out on an operating reactor is to satisfy specific operational, licensing, and contractual requirements. In many cases, however, measurements made on a routine basis are of sufficient quality to merit their use as reference measurements, and reporting these measurements in accordance with this guide is encouraged.

12171 **Automatic ultrasonic examination of light water reactor systems.** Hallinan, G.J. (Rockwell Int Corp, Canoga Park, Calif). *Mater. Eval.;* **33**: No. 8, 203-208(Aug 1975).

Atomics International is providing reactor owners an inservice inspection program to meet ASME Code requirements. These programs were initiated as part of AI's own fast breeder reactor program and have now been expanded to include both pressurized and boiling water reactors. AI provides program definition, conducts preservice and inservice inspections, and supplies all equipment. The paper presents the AI program and discusses recent inspection experience.

12172 **Dryout experiments in a 16- rod BWR geometry with six different radial heat flux distributions.** Marinelli, V.; Gaspari, G.P.; Greco, G.; Lucchini, F. (Com Naz Per l'Energ Nucl, Rome, Italy). *Am. Soc. Mech. Eng.,* [*Pap.*]; No. 75-HT-24, 9(1975).

Dryout experimental data, obtained in a BWR 16-rod geometry, are presented and discussed. About 200 runs have been carried out utilizing 6 test sections, 12 ft long, having different radial heat flux distributions: first, a bundle with uniform heat flux has been tested, as a reference test, and then conrner, side, and inner rods were overloaded by about 30 percent in order to study the influence of the radial peaking; the effect of a "cold" rod, simulating the gadolinium bearing rod in the fuel assembly, has been also investigated. All these data have been obtained at 70 bars of inlet pressure, mass flux from 120 to 2000 kg/m$sup 2$s, inlet quality from -50 up to 0 percent. The paper discusses the effect of the radial peaking patterns on the overall dryout power, on the rod dryout heat flux and on the dryout location. 12 refs.

12173 **Effect of reduced clearance and rod bow on critical power in full-scale simulations of 8*8 BWR fuel.** Nixon, R.B.; Matzner, B.; Lahey, R.T. Jr. (GE, San Jose, Calif). *Am. Soc. Mech. Eng.,* [*Pap.*]; No. 75-HT-69, 5(1975).

Boiling transition data are presented for evaluation of the effects of severe interior rod local geometry abnormalities. These tests were conducted using full-scale 8*8, 64-rod bundles with a 148-in. heated length, cosine axial heat flux shape, BWR local peaking and typical spacers. These tests to investigate interior rod reduced clearance and rod bow were performed in the ATLAS heat transfer loop of the General Electric Company in San Jose, California. Comparisons of the results show that for operating conditions of interest to BWR technology, the severe local abnormalities which were tested had virtually no detrimental effect on the critical power performance of the rod bundles. 5 refs.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 11785, 12162, 12164, 12165, 12167, 12168, 12299, 12440, 12450, 12453, 12461, 12463, 12467, 12468, 12469, 12472, 12483, 12491

12174 (AEOI—65) **Fuel requirements (without reprocessing) for Iran 1, 2, 3 and 4 nuclear power plants.** Peroomian, M.; Roustayian, S. (Atomic Energy Organization of Iran, Teheran. Nuclear Power Plants Management). Oct 1976. 16p. (NPP—76-2). Dep. NTIS (US Sales Only), PC A02/MF A01.

By use of a computer program written by the Nuclear Power Plant Management of the Atomic Energy Organization of Iran, the Yellowcake, natural uranium, and separative work unit (SWU) needs for the first core and ten reloads of the Iran 1, 2, 3 and 4 Nuclear Power Plants have been calculated for different tail assays.

12175 (ANL—77-70) **Alternative fuel cycle options: performance characteristics and impact on nuclear power growth potential.** Chang, Y.I.; Till, C.E.; Rudolph, R.R.; Deen, J.R.; King, M.J. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 43p. Dep. NTIS, PC A03/MF A01.

The fuel utilization characteristics for LWR, SSCR, CANDU and LMFBR reactor concepts are quantified for various fuel cycle options, including once-through cycles, thorium cycles, and denatured cycles. The implications of various alternative reactor deployment strategies on the long-term nuclear power growth potential are then quantified in terms of the maximum nuclear capacity that can be achieved and the growth pattern over time, subject to the constraint of a fixed uranium-resource base. The overall objective of this study is to shed light on any large differences in the long-term potential that exist between various alternative reactor/fuel cycle deployment strategies.

12176 (BAW—10118) **Core calculational techniques and procedures.** Romano, J.J. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Oct 1977. vp. and Wilcox Co., Lynchburg, VA.

Described are the procedures and techniques employed by B and W in core design analyses of power peaking, control rod worths, and reactivity coefficients. Major emphasis has been placed on current calculational tools and the most frequently performed calculations over the operating power range.

12177 (GKSS—77/E/8, pp 34-43) **Model for describing thermohydraulic feedback of the quasi steady-state calculation of a PWR.** Gundlach, W.; Schreiber, G.; Lutz, D. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976). In Physics of feed back proces in nuclear reactors.

In order to be able to account for the influence of the thermohydraulic feedback on the power and burn-up distribution in the core - and to a lesser degree on the reactivity behaviour of a PWR - a module for the reactor code system RSYST was developed determining the thermohydraulic state variable in a PWR fuel element. In the first section of this paper the characteristic features of this code are briefly outlined. It is followed by a section on the realization of the thermohydraulic feedback in the code system RSYST. In the third part it is reported on the first test runs.

12178 (GKSS—77/E/8, pp 33) **Influence of space-dependent water enthalpies on the burn-up behavior of a stationary pressurized water reactor.** Zeggel, W. (Technische Univ. Braunschweig (Germany, F.R.)). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976). In Physics of feed back process in nuclear reactors. Lectures of technical meeting of the KTG-Fachgruppe Reaktorphysik on 22nd and 23rd January 1976 at the research center Geesthacht.

12179 (TREE-NUREG—1066) **Irradiation effects test Series Scoping Test 1: test results report.** Quapp, W.J.; Allison, C.M.; Farrar, L.C. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1977. Contract EY-76-C-07-1570. 146p. Dep. NTIS, PC A07/MF A01.

The report describes the results of the first scoping test in the Irradiation Effects Test Series conducted by the Thermal Fuels Behavior Program, which is part of the Water Reactor Research Program of EG and G Idaho, Inc. The research is sponsored by the United States Nuclear Regulatory Commission. This test used an unirradiated, three-foot-long, PWR-type fuel rod. The objective of this test was to thoroughly evaluate the remote fabrication procedures to be used for irradiated rods in future tests, handling plans, and reactor operations. Additionally, selected fuel behavior data were obtained. The fuel rod was subjected to a series of preconditioning power cycles followed by a power increase which brought the fuel rod power to about 20.4 kW/ft peak linear heat rating at a coolant mass flux of 1.83 x 10^6 lb/hr-ft^2. Film boiling occurred for a period of 4.8 minutes following flow reductions to 9.6 x 10^5 and 7.5 x 10^5 lb/hr-ft^2. The test fuel rod failed following reactor shutdown as a result of heavy internal and external cladding oxidation and embrittlement which occurred during the film boiling operation.

12180 (UCRL—52265) **Investigation of pressure transient propagation in pressurized water reactor feedwater lines.** Sutton, S.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jul 1977. Contract W-7405-ENG-48. 70p. Dep. NTIS, PC A04/MF A01.

Results are reported of a study for the Nuclear Regulatory Commission (NRC) to provide a general understanding of pressure transient (water hammer) propagation in pressurized water reactor (PWR) steam generator feedwater piping systems. A typical feedwater network is defined, and pressure transient initiation is discussed, as well as the plausible pulse shapes reported. The analysis is performed by using the computer codes PTA and WHAM. Forces are calculated at elbows and valves by using momentum principles. The effects of pipe yielding, pipe wall friction, and elbow and value losses are included. Pipe yielding and elbow/valve effects are found to be important, and pressure magnitudes and forces are substantially reduced when these effects are included in the analysis. Typical pressure and force time histories are also given.

12181 (XN—75-39(NP)) **Generic fuel design for 15 x 15 reload assemblies for Westinghouse plants.** Pugh, R.A. (Exxon Nuclear Co., Richland, Wash. (USA)). 29 Jul 1977. 119p. Nuclear Co., Inc., Richland, WA.

A generic summary of the technical bases, analyses, and test results related to the principal design issues for 15 x 15 reload fuel for Westinghouse PWR's is presented. All key material properties used in the fuel performance analyses are listed along with the bases for their selection. The material and component behavioral models used are described. Stress-strain design limits are specified along with the bases for such limits. Methods for evaluating these limits are described.

12182 **Problems of neutron data analysis in operating WWER-440 reactors.** Novikov, A.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Kernenergie;* **20**: No. 10, 325-328(Oct 1977). (In German).

Experimental investigations performed in WWER-type reactors during start-up, in power range, during operation, and on the spent fuel are briefly characterized. Possibilities of extending and detailing these studies are specified. Their importance for verifying the physical calculations is pointed out. Some notion of the order of magnitude of the changes in neutron-physical characteristics during burnup and refueling is imparted by data calculated for the WWER-440 reactor of the Kola nuclear power plant, second unit.

12183 **Application of the point model to the determination of subcriticality of pressurized water reactors from their short-term behaviour.** Graetz, H. (Ingenieurhochschule Zittau (German Democratic Republic). Sektion Kraftwerksanlagenbau und Energieumwandlung). *Kernenergie;* **20**: No. 9, 280-282(Sep 1977). (In German).

Criteria are given for accuracy of the reactivity values calculated by means of the inhour equation or point-kinetic equations from the measured values. Short-term behaviour of the pressurized water reactor is simulated in a three-dimensional two-group diffusion approximation. The presupposed statical reactivity value is compared with those calculated from the simulated values on the basis of the point model.

12184 **Reactor physics experiments with the WWER-2 reactor of the Rheinsberg nuclear power plant. III. Xenon poisoning measurements.** Frach, K.H.; Greiner-Mai, H. (VEB Kernkraftwerk Bruno Leuschner, Greifswald (German Democratic Republic). Betriebsteil Kernkraftwerk Rheinsberg). *Kernenergie;* **20**: No. 8, 246-249(Aug 1977). (In German).

A review is given of measurements of non-steady state xenon poisoning after shutting down the WWER-2 reactor of the Rheinsberg nuclear power plant to zero power. The review includes eight campaigns of the reactor.

12185 **Off-shore power gets ready to manufacture.** Masters, R. *Nucl. Eng. Int.;* **22**: No. 261, 31-33(Aug 1977).

Progress is described on the work of Off-Shore Power Systems in constructing a manufacturing facility on Blount Island, in Jacksonville, Florida which is designed for production of a floating nuclear power plant. Programmes are outlined.

12186 **Financial foreclosure in the case of missing the deadline for raising objections.** *Energiewirtsch. Tagesfragen;* **27**: No. 7, 528-531(Jul 1977). (In German).

The administrative court at Wuerzburg, in its decision of March 25th, 1977 - No. W 122 II 74 - has rejected the suit of the community of Bergrheinfeld against the licence for the construction

of the Kernkraftwerk Grafenrheinfeld, and awarded costs of the proceedings, extra-judicial costs of two parties asked to attend included, against the plaintiff. The value in litigation was put at 75,000 DM. The rejection of the suit is based on missing the deadline for raising objections according to subsection (1) of section 3 of the AtAnlV (Nuclear Installations Ordinance). The main grounds upon which the judgment is based (admissibility of the action, but no foundation for it) are given in full.

12187 Construction-stop for Kernkraftwerk Muelheim-Kaerlich lifted. *Energiewirtsch. Tagesfragen;* **27**: No. 7, 532-531(Jul 1977). (In German).

The Higher Administrative Court of Rhineland-Palatinate in its decision of May 3rd, 1977 - 1 B 15/77 -, as opposed to the judgment of the Administrative Court at Koblenz of 2nd February, 1977, has set aside the construction-stop of the former, and rejected the action of the plaintiff reestablishing the suspensive power of the claim against the 7th notice to proceed from the nuclear licensing authority. The judgment of the Higher Administrative Court is the first higher court decision in connection with the so-called 'Freigabeverfahren' (procedure to cancel the enforcement order) in accordance with section 7 of the Atomic Energy Act. Furthermore, the verdict establishes the fact that 'not sooner than through the operation, and not through the construction of the nuclear power plant, the plaintiff becomes impaired in rights worth to be protected.' The main reasons upon which the judgment in based are given in full. Amongst other things, the statement of the Senate is remarkable in that it could not be taken into consideration that maintaining the construction-stop would mean at present the loss of about 400 places of work.

12188 Effect of rod bowing on CHF in PWR fuel assemblies. Markowski, E.S.; Lee, L.; Biderman, R.; Casterline, J.E. (Combust Eng, Inc, Windsor, Conn). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-91, 1-9(1977).

The effect on Critical Heat Flux (CHF) of rod bowing in Combustion Engineering (CE) Pressurized Water Reactor fuel assemblies was studied with 5 by 5 rod bundles for CE 15 by 14 assemblies. CHF decrease is observed only if bowing reduces the clearance between heated rods more than 50 percent. Bowing of an unheated rod even to contact with a heated rod had no adverse effect. 11 refs.

12189 Experimental evaluation of water surface heat exchange. Moy, H.C.; Sanghani, K.J. (Con Edison, New York, NY). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-41, 1-8(1977).

An investigation was conducted at Indian Point Power Station to determine the heat exchange rate between a water surface and the atmosphere. Experimental data were obtained using two sets of evaporation pans. One set of pans was located on the Hudson River near the power plant intake structure, to simulate the natural environment, including normal wave action. The other set of pans was placed on shore. The experimental heat transfer values obtained with the on-river pans were found to be considerably higher than values predicted from certain semiempirical formulae and than those obtained with the on-shore testing pans. 5 refs.

12190 Investigation into the gas phase composition of the Novovoronezh nuclear power plant fuel elements. Ageenkov, A.T.; Buravtsov, A.A.; Valuev, E.M.; Golubev, L.I.; Ershova, Z.V.; Kravtsev, V.V.; Shvoev, A.F. *At. Energ. (USSR);* **40**: No. 3, 203-206(Mar 1976). (In Russian).

3 refs.; 3 tables; for English translation see the journal Sov. J. At. Energy.

The composition of the gas phase has been investigated in the fuel elements from the Novo Voronezh Atomic Station which have worked 190 and 500 effective days at a specific power of 155 and 142 w/cm and cooled for two years and one year respectively. The mean fuel depletion is 7500 and 19 100 Mw per day per ton. The experimental procedure consists in puncturing the jacket of a fuel element and determining the composition of the sampled gas. A comparison of the sampled quantity of tritium and ^{85}Kr with the calculated accumulation of these isotopes allows the conclusion to be made that only small amounts of tritium and ^{85}Kr (0.12-0.27 and 0.06-0.28%, respectively) are liberated in the gas phase of fuel elements. There is 14.5 to 21.1 cm^3 of gas under the jacket of a fuel element with a 95% confidence probability. The main components of the gas phase (by volume) are: helium (65-95%) and hydrogen-protium (<32%). As to radioactive isotopes the gas contains ^{85}Kr and tritium both in a gaseous state and as water, the latter being the main form (99%) in which tritium exists in fuel elements. No effect of depletion depth upon the yield of gaseous fission products has been found.

12191 Optimization of the schemes and equipment parameters of the heat-power section of a two-loop atomic power station with water—water reactors. Popyrin, L.S.; Naumov, Yu.V.; Ivanov, A.A. *Power Eng.;* **14**: No. 2, 110-120(1976).

The problem of optimizing the heat-power section of atomic power stations with a reactor using water under pressure (of the water-water WWER type) is formulated. A description is given of its mathematical model. Results are presented of optimization investigations of the steam-generating installation and the turbo installation, as well as the results of complex engineering-economic optimization. An analysis is given of the effect of uncertainty in the original engineering-economic information of the results of the investigations.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 11720, 11796, 11797, 12293, 12296, 12300, 12441, 12450, 12451, 12473

12192 (Juel—1353) Filter concept for fission products in the primary coolant circuit of HTRs. Iniotakis, N. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Dec 1976. 31p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The knowledge of the behaviour of fission products in the primary coolant circuit of high temperature reactors is a fundamental prerequisite for the evaluation of the availability of reactor plants under regular operation and also for the risk of the maintenance personnel and the environment in the event of an accident. To clarify the behavior of the transport and deposition of fission products in primary circuits of HTR's an extensive experimental and theoretical research program is carried out in the Institute of Reactor Components of KFA. Within the framework of this program and on the basis of the results obtained till now a filter concept and a method of its optimization have been developed. The filter is suitable for purification of the primary coolant circuit of HTR-plants from non-gaseous fission and activation products. This filter can be installed directly in the primary circuit of the reactor. Its flow resistance is very low. Operating up to 1,000°C it can be used during the whole life of the reactor. Applying this kind of filter the contamination of the components behind the filter and so the radiation load of the maintenance personnel is reduced considerably.

12193 (Juel—1365) Numerical investigations of the fuel cycle for a 10 GW(TH)-OTTO-pebble-bed reactor with regard to high conversion ratio under special consideration of U-236 disconnexion through isotope-separation. Werner, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Dec 1976. 96p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

A conversion ratio of near 1.0 can be achieved in a pebble-bed reactor using the OTTO (once through then out) loading scheme, having an economic burn-up of the fuel, an economic power density and a moderation ratio, which is considered realistically for the future. The flexibility of the reactor concept and of the fuel element design allows to recycle the fuel during full-power operation. In the present report first the criteria are shown, which are necessary to reach a high conversion ratio. Further it is presented that the conversion ratio increases considerably by closing the fuel cycle in consequence of the building-up of U-233. In this way the fuel inventory and the fuel consumption can considerably be diminished. It is demonstrated that the building-up and the accumulation of U-236 effects an important deterioration of the neutron economy. By taking the reprocessed uranium through an isotope separation (for example: ultra-gas-centrifugation) and by separation of U-236 from the other uranium isotopes it is possible to reduce the fuel consumption considerably. The expenditure and the cost which are necessary for the isotope separation are presented.

12194 (Juel—1378) Study on the efficiency of a non-central neutron source for the 300 MW(e)-THTR-nuclear power station Schmehausen and comparison of two- and three-dimensional models. Scherer, W.; Gerwin, H.; Huebner, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jan 1977. 45p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The loading and start-up phase of the THTR 300 is controlled by an external neutron source. To treat positions for this source outside of the reactor axis 3-dimensional neutron physical computer models are necessary. The presented study treats the problem of the eccentrically arranged neutron source in 3-D-geometry. Beyond that comparisons to 2-D-approximations are performed and the model-specific differences are discussed with regard to the interpretation of detector signals. It is shown that the 2-D-models concerning integral results like multiplication constant and total reaction rates deviate only little from the 3-D-representation. On the other hand distinct differences exist for the neutron distribution, which influence the positioning of detectors. An arrangement of the detector in a distance of 1.5 m under the source plane of the reactor fulfills the discussed criteria.

12195 (Juel—1382) **Silicon carbide corrosion in HTGR fuel particles.** Gruebmeier, H.; Naoumidis, A.; Thiele, B.A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jan 1977. 31p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The silicon carbide layer in TRISO-coated HTR fuel particles occasionally is attacked during irradiation by fission products generated within the kernel material. Investigations to define the cause of the SiC corrosion are described, which included ceramographic, microradiographic and microanalytical studies on irradiated and unirradiated coated particles of various kernel compositions. The results of these studies showed that the presence of chlorine within the particle, in combination with certain metallic fission products or uranium, can lead to corrosion of the SiC layer. These results provided the basis for establishing a model, which relates the transport of fission products as volatile metal chlorides and their chemical reaction with the SiC corrosion. In addition this model is consistent with the fact that under the influence of a thermal gradient corrosive attack of the SiC occurs on the cooler side of the particle. The correlation between the occurrence of SiC corrosion during irradiation and heavy-metal transport observed in thermal gradient annealing studies of unirradiated particles of the same barch constitutes the basis for a new method for quality control.

12196 (Juel—1387) **Comparison of different energy group models in evaluating radial and azimuthal xenon transients at the example of HTR-cores.** Erven, U.; Lauer, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Feb 1977. 97p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The investigation concerns the influence of different few-group energy models for the neutron flux in computing xenon-induced spatial power instabilities in thermal reactors with the aid of the multi-group theory. Comparative transient calculations with a 1-, 2-, 4- and 7-group model have been performed at two typical HTR-models using a finite difference program. We considered the first azimuthal and the first radical oscillation mode of the cylindrical cores. The dependence of essential oscillation parameters like damping factor and period on the number of energy groups and on the choice of the energy intervals is determined. Trends are explained and the increased expenditure of computer work at larger group numbers is discussed in relation to the profit to accuracy recognizable therefrom. Essential results are, that the one-group formalism proves to be totally unsuitable for such calculations and that not unimportant but considerably case-dependent differences are also found to exist between the multigroup calculations. These latter effects are not merely due to differently calculated steady-state power density profiles.

12197 (Juel—1403) **High-temperature helium test facility (HHV). Layout and description of the facility.** Noack, G.; Weiskopf, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor mit Heliumturbinen). Mar 1977. 69p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The report describes the high-temperature helium test facility (HHV). Construction of this plant was started in 1972 by Messrs. BBC, Mannheim, on behalf of the Kernforschungsanlage Juelich. By the end of 1976, the construction work was in its last stage, so that the plant may start operation early in 1977. First of all, the cycle system and the arrangement of components are dealt with, followed by a discussion of individual components. Here, emphasis is laid on components typical for HHT systems, while conventional components are mentioned without further structural detail. The projected test programme for the HHV facility in phase IB of the HHT project is shortly dealt with. After this, the potential of this test facility with regard to the possible use of test components and to fluid- and thermodynamic boundary conditions is pointed out. With the unique potential the facility offers here, aspects of shortened service life at higher cycle temperatures do not remain disregarded.

12198 (Juel-Conf—23, pp 164-186) **'Cold' storage/transport of thermal energy up to 260°C.** Taube, M. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The substances containing hydrogen-bond seem to be preferred for the 'cold storage' and 'cold transport' of thermal energy in the range of up to 260°C. The criteria for selecting these substances are discussed. For the sake of illustration, the following systems are discussed in more detail: a) storage of thermal energy of approximately 260°C for power peaking with the help of latent heat of eutectic of sodium hydroxide, b) ammonia-water system for space heating cold storage and transport, c) ammonia-molten salt (e.g. aluminium trichloride-sodium chloride eutectic) as a system for power peaking storage and/or cold transport of heat for industrial users of steam (approximately 260°C, 60 bar) and/or district heating by means of railway transport.

12199 (SGAE—2686) **Mass-spectrometric determination in individual coated HTR fuel particles.** Strigl, A.; Bildstein, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Nov 1976. 11p. (CH—203/76). Dep. NTIS (US Sales Only), PC A02/MF A01.

A method is described which allows the simultaneous determination of fission and reaction gases in individual coated particles at temperatures up to 2000°C. The particles are heated under high-vacuum in a micro resistance-furnace up to the desired temperature. After preselected times the particles are crushed by action of a pneumatic cylinder. The gases liberated are fed into a quadrupolean-alyzer where they are analyzed in a dynamic mode. A peak selector allows the simultaneous measurement of up to four gases. The method is used routinely for the determination of fission gases (Kr and Xe) and of carbon monoxide which is formed as a reaction gas from oxide fuel. Precision and accuracy are in the order of a few percent. Detection limits for routine measurements are about 10^{-7} cm^3 (STP) for KR and Xe and 2×10^{-5} cm^3 (STP) for CO but can be lowered by special techniques.

12200 **HTGR fuel rods: carbon-carbon composites designed for high weight and low strength.** Bullock, R.E. (Gen At Co, San Diego, Calif). *J. Mater. Sci.;* **12**: No. 8, 1499-1518(Aug 1977).

The evolution of the process for fabricating fuel rods for the high-temperature gas-cooled reactor (HTGR) by injection and carbonization of a thermoplastic matrix that bonds close-packed beds of pyrocarbon-coated fuel particles together is reviewed for the fresh-fuel cycle, and a variant process involving a thermosetting matrix that would allow freestanding carbonization of refabricated fuel is discussed. Previous attempts to fabricate such injection-bonded fuel rods from undiluted thermosetting binders filled with powdered graphite were unsuccessful, because of damage to coatings on fuel particles that resulted from strong particle-to-matrix bonding in conjunction with large matrix shrinkage on carbonization and subsequent irradiation. These problems have now been overcome through the use of a diluted thermosetting matrix with a low-char-yield additive (fugitive), which produces a more porous char similar to that from the pitch-based thermoplastic used in the fabrication of fresh fuel. A 1-to-1 dilution of resin with fugitive produced the optimum binder for injection and carbonization, where the fired matrix in such rods contained about 20 wt% binder char and 80 wt% powdered graphite. 60 refs.

12201 **Method for measuring the velocity flow field in the vicinity of a moving cascade.** Bammert, K. (Technische Univ. Hannover (Germany, F.R.)); Mobarak, A. (Cairo Univ. (Egypt)). *Atomkernenergie;* **29**: No. 3, 171-175(1977).

Centrifugal compressors and blowers are often used for recycling the coolant gas in gas-cooled reactors. To achieve the required pressure ratios, highly loaded centrifugal compressors are built. The paper deals with a method of measuring the flow field in the vicinity of a moving impeller or cascade with hot wires. The relative flow pattern induced ahead of a cascade or impeller or the rotating wakes behind a moving cascade (which is important for loss evaluation) could be now measured with the help of a single hot wire. The wire should be rotated about the axis of the probe for 3 different inclinations with respect to the approaching flow. The method has been used for measuring the flow field in the vicinity of the inducer of a highly loaded centrifugal compressor. The results and the accuracy of the method are discussed and the mean values have been compared with the theoretically estimated velocities.

12202 **Prospects of development of gas turbines in nuclear power engineering.** Uvarov, V.V. (Moscow Higher Eng Sch im. N.E. Bauman, USSR). *Izv. Vyssh. Uchebn. Zaved., Mashinostr.;* No. 4, 63-76(1977). (In Russian).

An ordinary, closed, helium nuclear plant is compared with a two-loop helium/air power plant and the advantages of the latter are demonstrated. Both arrangements include dry cooling towers. The analysis shows that "Carnotization" of the cycle of the gas turbine plant using nuclear fuel heat considerably improves efficiency, including fuel consumption, costs of equipment, and operation (volumes of helium and its storage).

12203 **Heat exchanger with circular cross section for gaseous media.** Hodzic, A.; Stach, H. (to Hochtemperatur-Reaktorbau G.m.b.H., Koeln (Germany, F.R.)). German(FRG) Patent 2,459,189/A/. 16 Jun 1976. 15p. (In German).

The invention relates to improvements in the layout of a heat exchanger which, due to its small dimensions and good heat transfer properties, can be used as a recuperator in the primary circuit of a helium-turbine HTGR and is easy to assemble and repair. The counter-flow heat exchanger is made compact by means of a concentrical, annular-cylindrical arragement of the tube bundles. The gas header is of semispherical design and also serves as a supporting grate. The recirculation pipes are bed in loops along the circumference. Further details are illustrated by examples.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 12175, 12287, 12403

12204 (ZJE—146) **Measurement of thermal parameters of A-1 reactor fuel assemblies under operating condition. Program of in-core measurements. Pt. 3.** Krett, V.; Vlcek, J.; Majer, J.; Stepanek, K.; Horcicka, J.; Smolik, J.; Velechovsky, V.; Hajsman, V.; Krettova, A. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1975. 36p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The special E3, dia 112 mm fuel assembly for the first Czechoslovak nuclear power station is described. The fuel assembly is equipped with in-core instrumentation. The fuel assembly thermal characteristics as obtained by measurement and by calculation from design values are given.

12205 (ZJE—179) **Evaluation of surveillance specimens and in-service inspection of tubes of A-1 reactor heavy water calandria.** Mrkous, P.; Brumovsky, M.; Prepechal, J. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1976. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The results are summed up of operating trials of the A-1 heavy water reactor calandria. Attention was focused on measuring the changes in the pipe diameter resulting from corrosion losses. Three separate methods were used and the results showed good agreement. The suitability was proved of the ultrasonic method for measuring the wall thickness. Changes were also assessed of the mechanical properties of the structural materials of the calandria. The high radiation stability of the Al-Mg-Si alloy was confirmed.

12206 Optimization of a thermal power reactor by means of a non-linear programming model. Pavelescu, M.; Dumitrescu, H.; Ghilea, S. (Institutul de Fizica Atomica, Bucharest (Romania)). *Kernenergie;* **20**: No. 9, 276-280(Sep 1977).

The problem of optimizing a power reactor of the HWGCR type is dealt with. The reactor will be operated with a Roumanian vitroceramic fuel, essentially a mixture of UO_2 and SiO_2, that has to meet a great number of irradiation behaviour and reliability requirements. The purpose of optimization is to find the optimum reactor structure for which fuel burnup during the first campaign is maximum with some restrictions on the reactor integral parameters, such as thermal power, fuel mass, and cell power density, as well as some lattice and cell parameters, e.g. the reactor radius and the fuel cell pitch. Due to the problem structure corresponding to a non-linear programming model the SUMT method has been used for solving it by means of the ORPN computing programme.

12207 Model for estimating flux distributions in a thorium fuelled thermal reactor. Milgram, M.S. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *Atomkernenergie;* **29**: No. 4, 235-245(1977).

A well-known one-group, one-dimensional non-linear diffusion equation is shown to be applicable to a range of depletion and flux dependent problems, particularly to the case of a thorium fuelled thermal reactor with full channel on-power fuelling. The axial solutions are compared with solutions obtained in a more rigorous manner and are found to be in adequate agreement, with considerable savings in computation time. Some design curves, and stability estimates for the general axial case are presented.

12208 Lattice parameter measurements on cluster-type fuel for Advanced Thermal Reactor. Hachiya, Y.; Fukumura, N.; Nishi, A.; Iijima, K.; Sakata, H. (Power React and Nucl Fuel Dev Corp, Oarai-machi, Ibaraki-ken, Jpn). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 618-632(Nov 1976).

The behavior of neutrons in a highly heterogeneous unit cell consisting of D_2O moderator, H_2O coolant and a 28-pin fuel cluster contained in a pressure tube has been studied through lattice parameter measurements covering three different ^{235}U enrichments, four coolant void fractions and two lattice pitches. A strong dependence on coolant void was observed for the critical level and the lattice parameters, in the case of the smaller 22.5 cm pitch lattice, due to the positive effect on core reactivity exerted by the slowing-down faculty of H_2O in the epithermal energy region. For lattices devoid of coolent (100% void fraction), discrepancies in lattice paraters produced corresponding deviations in core reactivity amounting to 1% in excess of those incurred with other void fractions. 22 refs.

12209 Comparative study of the different in-core fuel management schemes. El-Meshad, Y.; Morsy, S.; El-Osery (Atomic Energy Establishment, Inshas (Egypt)). *Arab J. Nucl. Sci. Appl.;* **9**: No. 2, 105-116(Feb 1976).

A quantitative comparative study of the different in-core fuel management schemes has been performed using the spatial burnup computer code "UAFCC" and a reference reactor model of the pressurized heavy water natural uranium type. The conclusions drawn from the extensive numerical calculations, which can serve as general rules for heavy water reactors, indicate that although the "Batch" irradiation scheme requires less loading costs, leads to reasonable flat flux distribution and reduces thermal stresses on the fuel elements, it is very poor from the economical point of view. It can be used, however, if a maximum production rate of plutonium-239 with highest isotopic purity is required. The loading costs of the "In-Out" scheme is less than that of the "Out-In" one as well as the maximum burnup value obtained from the "In-Out" scheme is higher than that obtained from the "Out-In". The main disadvantage of the "In-Out" scheme is the higher thermal stresses that the fuel element may suffer during irradiation.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 11785, 12175, 12438, 12439, 12442, 12446, 12449, 12450, 12457, 12462, 12465, 12475, 12485, 12840, 12854, 12944, 13070

12210 (AI-ERDA—13207) **Water testing of the inducer pump.** Dunn, C.; Hoshide, R.K. (Atomics International Div., Canoga Park, Calif. (USA)). 15 Sep 1977. Contract EY-76-C-03-0824-024. 100p. Dep. NTIS, PC A05/MF A01.

The inducer pump, designed and fabricated as a test article to evaluate the inducer/impeller pump concept for providing improved suction performance of large sodium pumps, met or exceeded all performance goals. The inducer stage in front of the centrifugal impeller dramatically reduces the size of pumps. It was demonstrated that the inducer can operate at suction specific speeds in excess of 35,000, whereas conventional centrifugal pumps have demonstrated capability to only 12,000. The inducer pump employs several components of the 2000 and 4000 gpm NaK pumps from the Connecticut Aircraft Nuclear Engine Laboratory (CANEL) Programs. Use of the volute, thermal barrier and shaft oil seal from the CANEL pumps allowed acceleration and cost reduction of the Inducer Pump Program.

12211 (ANL—77-27) **Physics calculations for the Clinch River Breeder Reactor.** Kalimullah; Kier, P.H.; Hummel, H.H. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 176p. Dep. NTIS, PC A09/MF A01.

Calculations of distributions of power and sodium void reactivity, unvoided and voided Doppler coefficients and steel and fuel worths have been performed using diffusion theory and first-order perturbation theory for the LWR discharge Pu-fueled CRBR at BOL, the FFTF-grade Pu-fueled CRBR at BOL and for the beginning and end of equilibrium cycle of the LWR-Pu-fueled CRBR. The results of the burnup and breeding ratio calculations performed for obtaining the reactor compositions during the equilibrium cycle are also reported. Effects of sodium and steel contents on the distributions of sodium void reactivity and steel worth have also been studied. Errors and uncertainties in the reactivity coefficients due to cross-sections and the two-dimensional geometric representations of the reactor used in the calculations have also been estimated. Comparisons of the results with those in the CRBR PSAR are also discussed.

12212 (ANL-AFP—29) **Advanced fuels program. Quarterly progress report, April—June 1976.** Kittel, J.H. (comp.). (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 245p. .

Progress in studies on advanced LMFBR fuels is reported in the following areas: steady-state irradiation tests, performance modeling, design studies for FTR and CRBR, design studies for large plants, fuel properties, fuel chemical stability, environmental assessments, and safety.

12213 (ANL-CT—77-38) **Summary of test results from the testing of a Westinghouse Model WX-30950 compensated ionization chamber in the EBR-II NITF 0-1 Thimble at temperatures up to 370°C (Experiment NI-3).** Popper, G.F.; Elsbergas, V.J.; Yingling, G.E. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 39p. .

A summary of the results obtained from the performance testing of a high temperature gamma compensated ionization chamber-cable assembly in a typical Liquid Metal Fast Breeder Reactor (LMFBR) nuclear environment at temperatures up to 370°C is presented. A brief description of the detector packaging used for installation into the reactor, the test equipment used and the data collection system is also included. Based upon the results contained in this report, the WX-30950 compensated ionization chamber tested could be used as a linear dc channel detector in an uncooled, fixed position LMFBR environment at temperatures up to 370°C.

12214 (ANL-CT—78-6) **GE/CRBRP/IHTS mixing tee model perforated plate vibration test (in support of GE/CRBRP:DRS 51.32). Final report.** Chung, H.; Halle, H. (Argonne National Lab., Ill. (USA)). Sep 1977. Contract W-31-109-ENG-38. 71p. .

A series of vibration tests were performed on a quarter-scale model of CRBRP/IHTS mixing tee proposed by GE-FBRD to assess the vibration characteristics and the potential for flow-induced vibrations. The flow test conditions include simulated prototypic conditions using room-temperature water. The test results show that the fundamental natural frequency of the perforated plates is about 740 Hz in water and their displacements were less than 0.0025 mm (0.1 mils) RMS at the prototypic flowrate and at lower flowrates. The perforated plate response spectra were characterized by distinct, lightly damped resonances at all flowrates with high loop system static pressure. However, as the system pressure level was lowered the response spectra became less distinct, possibly due to the cavitation-type phenomena.

12215 (CONF-770807—50) **Finite-element formulations for the thermal stress analysis of two- and three-dimensional thin reactor structures.** Kulak, R.F.; Kennedy, J.M.; Belytschko, T.B.; Schoeberle, D.F. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 22p. Dep. NTIS, PC A02/MF A01.

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

In several postulated LMFBR subassembly-to-subassembly failure propagation events, it is hypothesized that the duct wall of an accident subassembly fails and deposits molten fuel on the outer wall of an adjacent subassembly. It is therefore necessary to determine if the deposited fuel will fail the adjacent wall and thus propagate the event. This entails a thermal stress analysis, and since at times the adjacent subassembly is internally pressurized, thermomechanical analysis are also of value. Solutions are presented for several elastic plastic thermal problems. Some of these examples are compared to available analytic solutions. In addition, the hypothetical accident of molten fuel deposition on the adjacent hexcan is addressed. Combinations of pressure and thermal loading are considered. It is shown that the principal feature of the response is a large in-plane compressive stress which would undoubtedly cause buckling.

12216 (CONF-770973—1) **Perspective on long-range nuclear energy options.** Harms, W.O. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

From 5. annual energy conference on energy policy options; Chicago, IL, USA (28 Sep 1977).

The study group whose effort is presented here concluded that the United States urgently needs to have a breeder option available for possible deployment before the year 2000 primarily because of uncertainties in the availability of fossil fuels and uranium supplies. It was recommended that the U/Pu LMFBR program proceed as planned, including prompt construction of the CRBRP and its associated fuel cycle facilities. Alternative cycle studies should be pursued, but without significantly delaying the current program. There are technological choices which, in suitable political contexts, may somewhat reduce proliferation risks; of these, only those that employ breeders preserve the breeder option (and the nuclear option in the long term. These alternatives must be coupled with political agreements to have any significant effect on proliferation potential internationally. These same political agreements should suffice to control the U/Pu breeder cycle; there is only a difference in degree between the U/Pu and the denatured Th/U-233 cycles.

12217 (FEI—622) **Analytical solution of some problems related with electromagnetic method of velocity measurement in complex channels.** Mikhin, V.I.; Zhukov, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1975. 20p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The objective of the work is to study a process of measuring the velocity of liquid-metall coolant by an electromagnetic method. The operation of electromagnetic sensors, which principle lies in a EMF effect caused in a rotating magnetic field of a conductor, has been analytically studied. The examination of two types of the electromagnetic sensor, one with and the other without a copper ring, is aimed at determining the effect of channel geometry and location of electrodes on the sensor signal. The analysis is performed for the case of a flat flow of the coolant. The formulas are recommended describing the effect of adjacent walls of various configurations on the signal of the sensor. The following conclusions have been drawn: in case of a flat flow of the coolant the effect of the adjacent walls of the channel on the sensor signal is largely governed by a size of the magnet, the use of a copper ring in the electromagnetic sensor makes it possible to diminish the effect of the adjacent walls of the channel upon the sensor signal, application of small-size magnets improves considerably the characteristics of electromagnetic sensors.

12218 (GEFR—00114(L)) **Evaluation of Hydraulic Test Model (HTM) flow distribution test results.** Lee, Y.J. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). May 1977. 37p. .

The CRBR steam generator Hydraulic Test Model (HTM) flow distribution test results have been evaluated, and it is found that the performance degradation due to the flow nonuniformity observed in the HTM test is negligible; 0.06% for the evaporator and nil for the superheater. Also, the fact that ambient temperature water was used in the test instead of hot sodium with temperature gradients does not introduce significant errors in applying the HTM test results for the tested flow rate range to the CRBR steam generator flow pattern.

12219 (GEFR—13771-22) **Critical experiments and analysis twenty-second quarterly report, January—March 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Apr 1977. Contract EY-76-C-03-0893-005. 77p. .

Current activities and technical progress for the period January through March 1977 are reported for two subtasks. Subtask A covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Subtask B is directed towards the analysis of advanced fuels critical experiments that can provide a consistent data base for testing the computational tools, nuclear analysis techniques and basic nuclear data which are used in the LMFBR design effort, and for evaluating the nuclear performance and safety characteristics of advanced fuel materials.

12220 (GEFR—14074-5) **Cooperative nuclear data and methods development fifth quarterly report, October—December 1976.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jan 1977. Contract EY-76-C-03-0893-021. 32p. .

Progress is reported in the cooperative evaluation of nuclear data and analytical design tools for LMFBRs.

12221 (GEFR—14074-6) **Cooperative nuclear data and methods development sixth quarterly report, January—Mach 1977.** (Analysis and Computer Systems, Inc., Burlington, Mass. (USA)). Apr 1977. Contract EY-76-C-03-0893-021. 31p. .

Progress is reported in the cooperative evaluation of nuclear data and analytical design tools for LMFBRs.

12222 (ICP—1050-3) **Fast reactor fission yields for ^{237}Np.** Maeck, W.J.; Emel, W.A.; Erikson, A.L.; Delmore, J.E.; Meteer, J.W. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Sep 1977. Contract EY-76-C-07-1540. 33p. Dep. NTIS, PC A03/MF A01.

Absolute fission yield data are presented for ^{237}Np irradiated in EBR-II. The measurement technique was isotope dilution mass spectrometry. This is believed to be the first published set of comprehensive ^{237}Np yield data based on mass spectrometric measurements. The neutron environment for the irradiation is defined.

12223 (IKE—5-202) **Computation of temperature and velocity fields in fuel elements of fast sodium-cooled breeders passed by a parallel flow.** Straub, G. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Oct 1976. 93p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

A factor of decisive importance for the safe operation of nuclear reactors is the knowledge of the precise temperature distribution in the fuel elements. This study is to improve the computation of velocity and temperature fields in hexagonal fuel elements passed by a sodium flow. For this purpose, the turbulent transport phenomena in the turbulent bundle flow and their repercussions on the velocity and temperature fields had to be investigated. The ARTIS computer program was developed for calculation of the velocity and temperature fields; its results are compared with four different experiments.

12224 (IKE—5-203) **Design and optimization of the electromagnetically energized liquid metal direct current conduction pumps.** Steiner, D. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Dec 1976. 152p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01.

Thesis.

For direct-current conduction pumps with electromagnetic field-energizing an optimization method is developed accounting for the effects of electrical geometrical and materials specific quantities in the form of dimensionless power products. With fixed pump geometry the conditions for the maximum efficiency, including Joule's losses in the transformer channel, in the field windings, and in the electric power supplies are first set up. In the case of series excitation, minimizing Joule's losses in the power supplies and field windings have the effect of tending towards a design for small currents. With the aid of dimensionless geometry parameters the effects of variable pump dimensions are superimposed upon the electrical design. The optimum design can be represented as an envelope of a multi-parameter set of curves in a mass-efficiency diagram.

12225 (INIS-mf—3663, pp 62-64) **Power generation versus fuel production in light-water hybrid.** Greenspan, E. 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

12226 (KFK—1276/4) **Fourth quarterly report 1976.** (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Apr 1976. 204p. (In German).

The 4th quarterly report 1976 describes activities which were carried out within the framework of the Fast Breeder project at the Gesellschaft fuer Kernforschung, Karlsruhe, or on its behalf. The sections refer to the following subjects: Fuel rod development; material studies and development; corrosion experiments and coolant analysis; physics experiments; reactor theory; fast breeder safety; instrumentation and signal processing for core control; effects on the environment; sodium technology experiments; thermo- and fluid-dynamic tests in gas; design studies concerning sodium-cooled breeders.

12227 (KFK—2356) **Experimental determination of temperature fields in sodium-cooled rod bundles with hexagonal rod arrangement and grid spacers.** Moeller, R.; Tschoeke, H.; Kolodziej, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Jan 1977. 46p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

Three-dimensional temperature fields in the claddings of sodium cooled rods were determined experimentally under representative nominal operating conditions for a SNR typical 19-rod bundle model provided with spark-eroded spacers. These experiments are required to verify thermohydraulic computer programs which will provide the output data for strength calculations of the high loaded cladding tubes. In this work the essentials are reported of the measured circumferential distributions of wall temperatures of peripheral rods. In addition the sub-channel temperatures measured over the bundle cross section are indicated, they are required to sustain codes for the global thermohydraulic design of core elements. The most important results are: 1) The whole fuel element is located within the thermal entrance length. 2) High azimuthal temperature differences were measured in the claddings of peripheral rods, which are strongly influenced by the distance between the rod and the shroud, especially for the corner rod. 3) With decreasing Penumber (< approximately 360) the circumferential temperature differences increase at a superproportional rate. The results of experiments described call for the settlement with priority of the following problems: 1) Experiments to determine the influence of the distance between the rods and the shroud on the temperature distribution in the claddings of peripheral rods, above all corner rods. 2) Completion of the presently used global design codes by multi-zone models applicable fro local calculations of critical bundle zones.

12228 (KFK-tr—521) **Rate of reactivity change of the BOR-60 reactor during the operation cycle.** Afanas'ev, V.A.; Efimov, V.N.; Krasnoyarov, N.V.; Skulkin, N.N.; Fedyakin, R.E. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Internationales Buero/Uebersetzergruppe). 1977. 6p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The result of measurements and calculations of the reactivity reserve at the BOR-60 reactor is reported. The results of the computations of the rate of change of the isotopic composition of the fuel during burn-up depending on the inventory of fissile material and the results of the computations aimed at showing the influence of radiation-induced volumetric swelling of the fuel on the reactivity change are represented graphically. The results of measurements and computations are compared with one another.

12229 (ORNL/TM—5889) **State of the art of fuel pin simulators for LMFBR out-of-reactor safety tests: status report.** Baucum, W.E.; MacPherson, R.E.; Clark, D.L.; McCulloch, R.W. (Oak Ridge National Lab., Tenn. (USA)). 22 Aug 1977. Contract W-7405-ENG-26. 178p. .

The liquid-metal fast breeder reactor (LMFBR) program out-of-reactor tests require high-performance, electrically heated fuel pin simulators (FPSs) to duplicate the configuration, heat flux profiles, and operational capabilities of nuclear fuel pins. Fuel pin simulators having a maximum heat flux of 315 W/cm^2 (10^6 Btu hr^{-1} ft^{-2}) in 1000°C (1830°F) sodium (category II) are considered state of the art when fabricated using conventional BN powder filling techniques, provided appropriate materials and fabrication techniques are used. In addition, fuel pin simulators of the same geometry for continuous operation in boiling sodium at 1000°C and having the capability for surviving for a short interval after void initiation and film dryout (category III) are also required in many test procedures. The results presented here have provided guidance for procurement, inspection, and assembly of fuel pin simulators for eight 19-pin bundles which have been extensively tested in the THORS facility.

12230 (PEL—250) **Development of accurate data for the design of fast reactors.** Rossouw, P.A. (Pretoria Univ. (South Africa). Faculty of Mathematics and Natural Sciences; Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Apr 1976. 99p. (In Afrikaans). Dep. NTIS (US Sales Only), PC A05/MF A01.

The proposed use of nuclear power in the generation of electricity in South Africa with the use of fast reactors in the country's nuclear program requires a method for fast reactor evluation. The availability of accurate neutron data and neutronics computation techniques for fast reactors is required for such an evaluation. The reactor physics and reactor parameters of importance in the evaluation of fast reacotrs are discussed, and computer programs for the computation of reactor spectra and reacotr parameters from differential nuclear data are presented. In endeavouring to increase the accuracy in fast reactor design, two methods for the improvement of differential nuclear data were developed and are discussed in detail. The computer programs which were developed for this purpose are also given. The neutron data of the most important fissionable and breeding nuclei (U^{235} x U^{238} x Pu^{239} and Pu^{240}) are adjusted using both methods, and the improved neutron data are tested by computation with an advanced neutronics computer program. The improved and orginal neutron data are compared, and the use of the improved data in fast reactor design is discussed.

12231 (WARD-OX—3045-23) **Oxide fuel element development. Quarterly progress report for period ending December 31, 1975.** Boltax, A.; Saling, J.H. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Apr 1976. Contract EY-76-C-02-3045-M. 151p. .

Progress is summarized in the following LMFBR fuel studies: coordination of mixed oxide irradiation tests; post-irradiation examination of fast reactor experiments; grid-type fuel assembly design; fabrication, development and testing of fuel assemblies; evaluation and analysis of fuel and cladding irradiation behavior; steady-state analytical methods; and transient code development. (DG)

12232 (WARD-XS—3045-19) **Physics evaluations and applications quarterly progress report for period ending July 31, 1977.** Yarbrough, M.; Arakali, V.; Davis, W.J. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Aug 1977. Contract EY-76-C-02-3045-012. 30p. .

Information is presented concerning analysis of the ZPR-6-7 benchmark problems for the RRD code evaluation working group; implementation of the VENTURE code on the Westinghouse NES CDC-7600 computer; calculation of breeding ratio and sodium void worth in a large LMFBR using (U-Th) oxide and (U-Th) carbide fuels; and ERDA meeting on physics requirements to support alternate fuel cycles.

12233 **Diagnosing malfunctions in liquid sodium hydrostatic bearings.** Wilcock, D.F. (Mech Technol Inc, Latham, NY). *Lubr. Eng.;* **33**: No. 8, 412-416(Aug 1977).

One of the principal methods being developed for the fast breeder reactor power plant for the transfer of heat from the reactor core is the use of a liquid sodium transfer loop. Operation of this loop requires large pumps capable of handling liquid sodium at temperatures over 1000 F. The lower impeller bearing in these vertical shaft pumps is conventionally a multipocket hydrostatic bearing supplied with pressure from the pump discharge. Continued operation of this bearing is vital to the power plant operation. Hence, diagnosis of its condition is important to assessing plant condition and scheduling outages for repair. A logical analysis of hydrostatic bearing faults and the observable symptoms which may be displayed as the result of each fault can be used to establish a desirable level of instrumentation. If proximeters, pressure sensors, and a bearing supply flow meter can be used, each type of fault that has been identified can be distinguished clearly. With this level of instrumentation, the power plant operator can reach rational decisions related to continued operation of a large liquid metal pump after a bearing malfunction has been signalled. Furthermore, the fault-symptom logic forms a natural basis for automation of the instrumented surveillance of large sodium pumps.

12234 **Higher Administrative Court at Muenster expresses doubts concerning the constitutional character of section 7 of the Atomic Energy Act.** *Gut;* No. 19, 1-2(Jul 1977). (In German).

In connection with the procedure in contentious matters over the SNR 300, the chairman of the 7th senate of the Higher Administrative Court at Muenster has sent participants in the procedure a document, in which it is pointed out that in order to come to a decision in the law case in question within the framework of dutiful exercise of the judicial right of control, the constitutional character of section 7 of the Atomic Energy Act would have to be examined and also, whether the principles of basic law would be still warranted if the executive, and not parliament, makes decisions with considerable consequences (ultimate storage, plutonium industry, etc.) -

Note: The matter was passed on to the Federal Constitutional Court on the 18th August 1977 in order that the constitutional character of section 7 of the Atomic Energy Act may be examined.

12235 Nuclear fuel assemblies. Butterfield, R.S.; Garner, D.L.M. (to UKAEA London Office). British Patent 147,5764/A/. 10 Jun 1977. 6p.

Reference is made to nuclear fuel assemblies designed for cooling on the 'tube-in-shell' principle in which the fuel is contained by a shell and is cooled by coolant passed through tubes extending through the shell. It has been proposed to employ coated particle fuel as a porous bed on the tube side and the bleed coolant from the tubes into direct contact with the fuel particles. In this way heat is extracted both by direct contact with the fuel and by heat transfer through the coolant tube walls. The system described aims to provide an improved structure of tube and shell for a fuel assembly of this kind and is particularly suitable for use in a gas cooled fast reactor, being able to withstand the neutron flux and high temperature conditions in these reactors. Constructional details are given.

12236 (KFK-tr—522) Fission product monitoring in the sodium coolant during operation of a fast reactor. Ivanov, V.B.; Polyakov, V.I.; Chechetkin, Yu.V.; Shipilov, V.I. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Internationales Buero/Uebersetzergruppe). Mar 1977. Translation of Operativnyi kontrol produktov deleniya v natrievom teplonositele bystrogo reaktora. 5p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

A Compton integral-gamma spectrometer is described serving to monitor the state of the core of fast reactors and to assess the activity of the coolant during operation.

12237 Evaluation of desirable accuracy for nuclear data in fast reactors by optimization method. Miki, K.; Inoue, K. (Hitachi Ltd., Kawasaki, Kanagawa (Japan). Atomic Energy Research Lab.). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 1, 58-64(Jan 1977).

The desirable accuracy of nuclear data for minimizing the design margin in fast reactor nuclear designs is evaluated through an optimization method, in which a parameter termed the "degree of difficulty" has been introduced in order to represent the relative degree of difficulty expected to be encountered in improving the accuracy of the data. This parameter serves to determine the desirable accuracy, by which the design margin could be reduced the least onerously, to obviate uselessly severe requirements being imposed on the accuracy demanded of data with high sensitivity coefficients. Application of this method to the equilibrium core of a prototype fast reactor leads to the conclusion that nuclear data that should to best advantage be improved in accuracy are: sigma sub(f)sup(41)(400 -- 0.5keV), sigma sub(f) sup(49)(1.4MeV -- 10keV) and sigma sub(c)sup(28)(100 -- 0.5keV). Furthermore, it is indicated that the ratio between the desirable accuracy and the present uncertainty level nuclear data is roughly inversely proportional to the square root of the product of the sensitivity coefficients and the present uncertainty level of nuclear data.

12238 Flow model test development of CRBRP intermediate heat exchanger. AbuRomia, M.M.; Vosch, R.J. Jr.; Cho, S.M.; Dietz, D.; Jaisingh, G. (Foster Wheeler Dev Corp, Livingston, NJ). *Am. Soc. Mech. Eng., [Pap.];* No. JPGC-NE-10, 1-11(1977).

The details of these tests, flow data achieved, finalized design configurations of the flow distribution devices, and final interpretation of the results are given in this paper. The tests consist of the: Primary Inlet Plenum Flow Model Test which has the objective of finalizing the design of the primary flow inlet plenum configuration that results in a circumferentially uniform flow entering the tube bundle; Tube Bundle Flow Model Test which has the objective of achieving optimum design configurations for the flow baffles in the bundle, which is based on the baffles capability to create the necessary forced fluid mixing of the shell side flow within the pressure drop limitation imposed on the unit's design; and Intermediate Flow Model Test with its objective of confirming the design of the intermediate flow inlet plenum, which has a hemispherical shape with a ring baffle attached, in distributing the flow evenly among the tubes. The paper includes details of the flow fields within various test models in a wide range of operating flow rates. 2 refs.

12239 Study of the density interface in a stratified LMFBR outlet plenum. Lorenz, J.J.; Howard, P.A. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-23, 1-8(1977).

Tests were performed with small scale model plenums using water as the test fluid. The movement of the interface was detected by vertical strings of closely spaced thermocouples. Considerable wave motion and unsteadiness were observed at the density interface. As the interface passed a given thermocouple location, the temperature was observed to drop abruptly while oscillating in the process. Using the theory of free submerged jets, a correlation was developed for the rise rate of the interface in terms of the Froude number based on local jet impingement parameters. This correlation can readily be incorporated into a computer code for outlet plenum analysis. 12 refs.

12240 CRBRP outlet plenum behavior during steady state and transient conditions. Howard, P.A.; Lorenz, J.J.; Howarth, W.L.; Novendstern, E.H. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-32, 1-8(1977).

Of major concern in this study were buoyancy-induced flow stratification and thermal oscillations ("thermal striping"). Tests were performed with a 1/10 scale model CRBRP outlet plenum complete with the Upper Internals Structure (UIS) using water as the test fluid. The components in the upper region of the outlet plenum experienced the characteristic temperature drop and recovery during the early development of flow stratification; temperature oscillations were observed at the stratification interface and in the neighborhood of the fuel assembly/blanket assembly boundary. Temperature measurements obtained provided the thermal boundary conditions required for calculating thermal stresses. 7 refs.

12241 Validation of turbulence models for LMFBR outlet plenum flows. Chen, Y.B.; Golay, M.W. (MIT, Cambridge, Mass). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-34, 1-8(1977).

Small scale experiments involving water flows are used to provide mean flow and turbulence field data for LMFBR outlet plenum flows. Measurements are performed at Reynolds number (Re) values of 33000 and 70000 in a 1/15 - scale FFTF geometry and at Re = 35000 in a 3/80-scale CRBR geometry. The experimental behavior is predicted using two different two-equation turbulence model computer programs, TEACH-T and VARR-II. It is found that the qualitative nature of the flow field within the plenum depends strongly upon the distribution of the mean inlet flow field, importantly also upon the degree of inlet turbulence, and also upon the turbulent momentum exchange model used in the calculations. In the FFTF geometry, the TEACH-T predictions agree well with the experiments. 7 refs.

12242 Combined forced and free laminar convection in verticale rod bundles with longitudinal flow. Ramm, H.; Johannsen, K. (Inst fuer Kerntechnik, Berlin, Ger). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-44, 1-12(1977).

The heat-transfer problem of combined forced and free convection by fully developed laminar flow in a vertically mounted reactor fuel rod assembly has been solved analytically for both upflow and downflow. Results reveal the strong augmentation of buoyancy effects by radial gradients in the power generation across the assembly. 12 refs.

12243 Pipe connector. Sullivan, T.E.; Pardini, J.A. (to Energy Research and Development Administration). US Patent Application 749,206. 9 Dec 1976. 6p.

A safety test facility for testing sodium-cooled nuclear reactor components includes a reactor vessel and a heat exchanger submerged in sodium in the tank. The reactor vessel and heat exchanger are connected by an expansion/deflection pipe coupling comprising a pair of coaxially and slidably engaged tubular elements having radially enlarged opposed end portions of which at least a part is of spherical contour adapted to engage conical sockets in the ends of pipes leading out of the reactor vessel and into the heat exchanger. A spring surrounding the pipe coupling urges the end portions apart and into engagement with the spherical sockets. Since the pipe coupling is submerged in liquid a limited amount of leakage of sodium from the pipe can be tolerated.

12244 Design basis of and materials requirement for sodium heated steam generators for fast reactors. Chetal, S.C.; Sabherwal, M.C. (Reactor Research Centre, Kalpakkam (India)). *NML (Natl. Metall. Lab.) Tech. J. (Jamshedpur, India);* **18**: No. 4, 73-80(Nov 1976).

An attempt has been made to categorise the various materials which have been considered for a sodium heated steam generator. Choice of steam parameters, choice of sodium temperature, selection of material, problems of sodium heated generators, R and D efforts for indigenous materials for steam generators etc. have been discussed. It is concluded that stabilised ferritic steel will be a good selection as a sodium heated steam generator material under Indian conditions.

12245 Fundamental experiment of potassium heat exchanger using principle of heat pipe. Sumida, I.; Kotani, K. (Hitachi Ltd, Ozenji, Kawasaki-shi, Jpn). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 1, 648-655(Nov 1976).

A potassium heat exchanger is described which features separate construction of primary and secondary coolant systems. A small amount of potassium plays a role as an intermediumte media of heat transportation. Heat is transfered by evaporation and condensation of potassium on the surfaces of the primary and secondary coolant pipings, respectively. The tests were performed in the temeprature range of 200 to 300°C and the maximum heat transfer reaches 1.3 kW (heat transfer rate at the primary heating source: 8.6 W/cm² at 300°C. 8 refs.

12246 British nuclear energy society. Vaughan, R.D. *Energy Dig. (London)*; 4: No. 2, 4-11(Apr 1975).

The paper is concerned with the efficient use of the world's very limited uranium resources and the contribution which can be made by the gas-cooled fast breeder reactor. The fast breeder reactor does not require the mining of any fresh uranium. It relies for its fuel on the byproducts of the thermal reactor program Pu239 and U238 from which it then breeds more Pu239. It is assumed (optimistically) that the first commercial fast breeder will be brought into operation in 1985. Helium is attractive as the coolant because it is inert, transparent and non-radioactive, which helps in maintenance, inspection, and operation. But helium also has good heat transfer and transport properties and enables a good breeding performance because it has little effect on the fast neutron spectrum. The early introduction of breeder reactors will enable a larger program to be achieved, but to be effective they must have a breeding performance superior to those now available. Using breeders with a plutonium doubling time of 12 years, it should be possible to stop the increase in Europe's demand for uranium by the end of the century and secure virtual independence from outside supplies 25 years later.

12247 Boundary-value thermal-hydraulic solution in a reactor fuel bundle. Sha, W.T.; Schmitt, R.C.; Huebotter, P.R. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 75-HT-48, 13(1975).

A new computational model for steady-state, single-phase, thermal-hydraulic, multichannel analysis is presented. The model accounts for the conservation of mass, energy, and momentum subject to pressure-drop boundary conditions and leads to a nonlinear multipoint boundary-value problem. The turbulent interchange, radial thermal conduction and forced flow due to the wire-wrap or grid between the channels are explicitly taken into account. The most important features of this new computational model are that: the effect of axial flow area variation has been incorporated into the derivation of governing equations; the crossflow approximation has been improved so that the assumption of constant transverse momentum flux in the direction under consideration is removed; and partial flow blockage occurring anywhere along the flow path can be analyzed, and the effect on the inlet mass velocity redistribution taken into account. 39 refs.

12248 Thermal/hydraulic performance test results of sodium-heated steam generator model employing a duplex tube. Waszink, R.P.; Hwang, J.Y.; Efferding, L.E. (Westinghouse Electr Corp, Tampa, Fla). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 75-HT-65, 11(1975).

The paper presents thermal/hydraulic performance results of testing a single duplex tube sodium-heated steam generator model in the GPL-1/SWL-1 (sodium/water loops) test facility at the Westinghouse Advanced Reactors Division. The Small Steam Generator Model (SSGM) was designed, built and tested to proof-test a single tube of duplex wall construction at conditions identical to the alternate concept evaporator for the Clinch River Breeder Reactor Plant (CRBRP). 21 refs.

12249 Preliminary thermal-hydraulic design and predicted performance of the Clinch River Breeder Reactor core. Carelli, M.; Markley, R.A. (Westinghouse Adv React Div, Madison, Pa). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 75-HT-71, 8(1975).

The preliminary thermofluids design of the core assemblies of the Clinch River Breeder Reactor Plant (CRBRP) is presented along with the predicted performance for various plant operating conditions. The selected radial blanket assemblies shuffling scheme and the new approach adopted for fuel and blanket assemblies orificing is discussed. Relevant thermofluids parameters (assembly flow rate and mixed mean outlet temperature, fuel rod temperatures, fission gas plenum pressure, etc.) are presented. Highlights of a detailed uncertainties study performed are summarized. This preliminary analysis has shown that the CRBRP core behavior is compatible with design limits and requirements; future developments for a final analysis are outlined. 4 refs.

12250 Prediction of local and integral turbulent transport properties for liquid-metal heat transfer in equilateral triangular rod arrays. Ramm, H.; Johannsen, K. (Tech Univ Berlin, Ger). *Am. Soc. Mech. Eng.*, [*Pap.*]; No. 75-HT-NN, 1-6(1975).

A theoretical method based on a phenomenological turbulence model has been applied to evaluate turbulent transport properties for liquid-metal heat transfer in bare equilateral triangular rod bundles. Results obtained for local distributions of thermal eddy diffusivity in the various directions are presented in terms of correlations. From a subsequent solution of the three-dimensional heat transfer problem between two characteristic interior subchannels under conditions characteristic for tracer-type mixing experiments, integral thermal mixing coefficients and thermal length scales have been evaluated. 10 refs.

12251 Brazed thermocouple pass-through for sodium service in a liquid-metal-cooled fast breeder reactor. Walker, D.E. Dearborn, MI; Society of Manufacturing Engineers (1975). 7p.

Sensors installed in special fuel elements for the EBR-II reactor have 30 ft long leads that pass from the Na environment through a sealed bulkhead. An H atmosphere, induction heated brazing furnace has been constructed to braze 20 to 26 separate sensor leads at one time. The brazed seals are leak-tight and the sheath wall has less than 10 percent interaction with the braze alloy.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 12186, 12187, 12234

12252 (IRS-A—12) General report IRS-literature 1965-1976. Final report. Schulz, W. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Dec 1976. 59p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The Institut fuer Reaktorsicherheit der TUeV e.V. (IRS) is of central importance in matters of licensing. It was jointly founded in 1965 by the eleven TUeVs of the Federal Republic of Germany and West-Berlin, by the Germanischer Lloyd and the then Federal Ministry for Scientific Research. After 12 sucsessful years the IRS will terminate its activities on December 31st, 1976, and together with the Laboratorium fuer Reaktorregelung und Anlagensicherung (LRA) at the TU Munich, Garching, it will be from January 1st, 1977 onwards part of the Gesellschaft fuer Reaktorsicherheit (GRS) mbH, a newly founded corporation. The activities of IRS and LRA will be continued by the GRS starting from January 1st, 1977. All IRS' report series and information services listed in this report are thus running out. The new corporation will build up its publications on the basis of the experience gained by IRS and LRA.

12253 (Juel—1407) Silver release from coated particle fuel. Brown, P.E.; Offermann, P.; Nabielek, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekt Hochtemperaturreaktor-Brennelemente). Mar 1977. 45p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The fission product Ag-110 m released from coated particles can be the dominant source of radioactivity from the core of a high temperature reactor in the early stages of the reactor life and possibly limits the accessability of primary circuit components. It can be shown that silver is retained in oxide fuel by a diffusion process (but not in carbide or carbon-diluted fuel) and that silver is released through all types of pyrocarbon layers. The retention in TRISO particles is variable and seems to be mainly connected with operating temperature and silicon carbide quality.

12254 (NUREG—0020(Vol.1)(No.2)) Licensed operating reactors. Operating units status report, data as of 09-30-77. Cintula, T.C. (ed.). (Nuclear Regulatory Commission, Washington, D.C. (USA)). Oct 1977. vp. NTIS $10.00.

The report is divided into three sections. The first section contains summaries of operation of commercial U.S. nuclear units, the Glossary, and any known Errata. The second section contains two pages of detailed information on each individual nuclear unit including information provided by NRC Regional Offices and I and E Headquarters and information received from the utilities concerning the operation of their unit during the report period. The third section is an Appendix which contains copies of the letters establishing the procedures for publication of this report, comparative statistics, identification of nuclear power plants within regional Electrical Reliability Councils, the relative status of U .S. nuclear electrical production to all U.S. electrical production by state, and Regulatory Guide 1.16 Revision 4.

12255 (NUREG—0030-77/10) Nuclear power plants. Construction status report, data as of September 30, 1977. (Nuclear Regulatory Commission, Washington, D.C. (USA)). Oct 1977. vp. NTIS $10.00.

The report provides information for monitoring the progress of construction of nuclear power plants. It provides data for synchronizing the licensing process with predicted fuel loading dates, as well as providing a central federal government report for commercial reactor construction. It utilizes data collected from the utilities sponsoring these projects and the Office of Inspection and Enforcement, NRC, and analyzed by the Office of Management Information and Program Control in the implementation of Management Information Systems. T he status of 93 plants authorized to engage in construction activities is summarized. This total includes (4) plants with construction exemptions, and (11) plants with Limited Work Authorization Permits.

12256 (NUREG/PRDI—77/10) Power Reactor Docket Information. (Department of Energy, Oak Ridge, Tenn. (USA). Technical Information Center). Oct 1977. 74p. TIC.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence.

The Table of Contents is arranged both by Docket number and by nuclear power plant name.

12257 (RDT-INDEX—(10-77)) **RDT Standards index.** (Department of Energy, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). 19 Oct 1977. Contract W-7405-ENG-26. vp. .

12258 (RDT-STATUS—(10-77)) **RDT Standards. Status report.** (Department of Energy, Washington, D.C. (USA). Div. of Reactor Development and Demonstration). Oct 1977. Contract W-7405-ENG-26. 27p. .

The October 1977 Status Report of US RDT Standards covering the period of July through September 1977 is presented.

12259 Participation of the citizen in the approval procedures for power stations. Puettner, G. (Hochschule fuer Verwaltungswissenschaften, Speyer (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 16, 545-550(Aug 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

The author first deals with the causes, and the forms taken, of the trend towards more citizen participation. In detail he then deals with the complaint from an association as the most important cause of disagreement in citizen participation; also discussed are the disquiet under constitutional law concerning control of the administration by associations and courts instead of by the government, problems of the law protection system, and practical considerations. Finally, he indicates reasonable possibilities of participation by associations, e.g. in relation to the provision of a particular site. 46 refs.

12260 Publication concerning the amendment of the publication concerning the formation of a 'Kerntechnischer Ausschuss' dated 14th July 1977. *Bundesanzeiger;* **29**: No. 147, 6(Aug 1977). (In German).

This amendment to section 8 'sub-committees' covers: make-up of sub-committees, quorum, transferability of the right to vote.

12261 Practice of administrative courts in nuclear power plant cases. Goetz, V. (Goettingen Univ. (Germany, F.R.). Inst. fuer Voelkerrecht). *Atomwirtsch., Atomtech.;* **22**: No. 7, 404-405(Jul 1977). (In German).

Most recently the practice of administration courts in the Federal Republic of Germany has acquired a significance to the development of the peaceful uses of nuclear energy in that country which can hardly be overestimated. In a number of cases, relief proceedings have greatly delayed licensing procedures and the construction of nuclear power plants although, so far, neither partial permits nor preliminary decisions have been canceled by courts of law. Since courts of first instance in most cases had to venture into new territory, clarifications of principle will only gradually come forth as courts of appeal become involved. One particular aspect that has emerged from the experience made so far is the proper dimensioning of the procedure in the main issue for which basic decisions appear to be necessary about the scope and function of the evidence presented by experts.

12262 Procedural problems in court practice regarding the German Atomic Energy Act. Kuhnt, D. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G. (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 7, 406-411(Jul 1977). (In German).

Some important repercussions of court practice upon the attitude of administrative authorities in the execution of licenses under the Atomic Energy Act have already been noted. The report covers details of court practice in legal matters of administrative court procedures, especially the scope of the documentation to be interpreted and the objections, legal problems of court procedure, especially with respect to the restoration of the delaying effect of an action, the right of action, and the consideration of interests.

12263 New rules of procedure for licensing under the Atomic Energy Act. Scharnhoop, H. (Bundesministerium des Innern, Bonn (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 7, 401-402(Jul 1977). (In German).

The new rules of procedure for plant licensing under Section 7 of the German Atomic Energy Act, which entered into force March 1, 1977, cover only the licensing procedure under the Atomic Energy Act. The new ordinance, which replaces the Atomic Installation Ordinance, is intended to streamline the licensing procedure, to improve the participation of third parties in the licensing procedure, and to improve the rules of public hearings.

12264 Further development of nuclear law and the nuclear licensing procedure. Schmieder, K.; Feuerborn, A.; Knueppel, H.C. (Muenster Univ. (Germany, F.R.). Inst. fuer Arbeits- und Wirtschaftsrecht). *Atomwirtsch., Atomtech.;* **22**: No. 7, 402-403(Jul 1977). (In German).

From 5. German symposium on nuclear law; Muenster, Germany, F.R. (8 Dec 1976).

The 5th German symposium on nuclear law, held at the University of Muenster, dealt with the further development of nuclear law, in particular various aspects of the nuclear licensing procedure. Special regard was paid to problems connected with the 4th Amendment to the Atomic Energy Act, issued in 1976, and with the 5th Amendment now being elaborated.

12265 Nuclear power, nuclear exports, and the non-proliferation of nuclear weapons. Hildenbrand, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Bereich Brennelemente, Brennstoffkreislauf). *Atomwirtsch., Atomtech.;* **22**: No. 7, 374-380(Jul 1977). (In German).

Developed and developing countries alike unfortunately have no other options in replacing oil in electricity generation than to use coal or nuclear energy. As far as the supplier countries are concerned, there is no doubt that nobody is interested in adding to the proliferation of nuclear weapons. On the other hand, the future electricity requirement in the developing countries, especially the need for nuclear power plants, represents a considerable market in the medium and long term that the supplier countries cannot simply ignore because they must seek to secure their export shares in order to protect jobs at home. For the receiver countries it is a matter of principle to achieve the highest possible degree of independence in energy generation so as to be able to guarantee continuity of supply. The interest in building up national fuel-cycle activities is also closely linked with the creation of jobs in the receiver countries and with the efforts of these countries to straighten out their balance of payments situation. 10 tables, 7 refs.

12266 Guidelines for Nordic Co-operation concerning nuclear installations in the border areas between Denmark, Finland, Norway and Sweden in respect of nuclear safety conditions. *Nucl. Law Bull.;* No. 19, 38-39(May 1977). (In English, French).

These Guidelines came into force between the four Contracting Parties (Denmark, Finland, Norway and Sweden) to the Agreement on 15th November 1976. The Agreement is the outcome of work undertaken these past years in the Nordic Reactor Safety Working Group and the Nordic Atomic Energy Liaison Group. The purpose of the Guidelines is to establish a consultation mechanism between the authorities of Nordic countries likely to be affected by a nuclear installation siting project by another party to the Agreement near their borders. Information imparted during such consultation is intended mainly to improve assessment of the projected site for the installation and its environment. Discussions may also cover the actual safety of the installation itself.

12267 Comparative review of public participation in nuclear licensing procedures in certain European countries. Pelzer, N.; Bischof, W. (Goettingen Univ. (Germany, F.R.)). *Nucl. Law Bull.;* No. 19, 53-72(May 1977). (In English, French).

Public participation in the licensing procedure for nuclear installations is an increasingly important question, given the opposition shown in numerous countries as regards the use of nuclear energy. The arrangements for this participation differ considerably according to different political/legal systems. This Article illustrates these differences and analyses in detail the conditions for public participation in the licensing procedure in several European countries, e.g. France, The Netherlands, Sweden and Switzerland. This analysis demonstrates in particular that in Europe there are fairly few national regulations providing for a genuine public consultation procedure on nuclear projects especially in the form of public enquiries. It also emphasises the complexity of the problems raised by organising participation by the public.

12268 Reorganisation of the French Atomic Energy Commission. Glaize, G. (CEA, 75 - Paris (France)). *Nucl. Law Bull.;* No. 19, 43-52(May 1977). (In English, French).

The Atomic Energy Commission (CEA) has somewhat distinctive features when compared to other French public administrations. The Commission had been designed, when created in 1945, as a body very close to the Head of Government with, at the same time, great freedom of action; these two aspects demonstrated the importance accorded to its duties and the desire to assure its efficiency. The evolution of the Commission subsequently resulted in reducing these differences and strengthening the ministerial supervision as well as the role of the Administrator-General as compared with that of the High Commissioner. In the 1970s the Commission's structures developed in another direction, in view of the reorientation of its duties in the perspective of the development of the private nuclear sector and the increasing importance of nuclear safety questions. This reorganisation resulted in the creation of fairly autonomous operational units and a number of subsidiary bodies and specialised institutes. The outcome of this exercise has been to give the CEA a very diversified structure which is not as centralised as previously.

12269 Fuel oil systems for standby diesel-generators. Chicago; American Nuclear Society (1976). 17p.

This Standard provides the design requirements for fuel oil system for diesel-generators that provide standby power for a nuclear power generating station. The system includes all essential equipment from and including fuel oil storage tanks up to the terminal connection on the diesel-engine. It does not include that portion of

the fuel oil system supplied by the diesel-generator manufacturer which is in accordance with Trial-Use Criteria for Diesel-Generator Units Applied as Standby Power Supplies for Nuclear Power Generating Stations, IEEE-387-1972. This definition of scope is intended to exclude only those factory-assembled, engine-mounted appurtances supplied with a diesel-generator unit. Integral tanks are, however, within the scope of this Standard. It also excludes motors, motor control centers, switchgear, cables, and other electrical equipment which is used in operation of the fuel oil system, except to define interface requirements.

ECONOMICS

REFER ALSO TO CITATION(S) 12577

12270 (Juel-Conf—23, pp 5-16) **National economic aspects of non-electric secondary energy carriers produced by nuclear plants.** Barnert, H.; Bohn, T. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industrial processes.

The potential for nuclear process heat is being disclosed on the basis of energy requirements and, in particular, with a view to heat demand. Secondary energy carriers, which can be produced with the aid of nuclear process heat, are gaining particular significance in a time where shortages in oil and natural gas are to be expected. Competing with electric power, they will acquire a noticeable share in the supply of final energy for reasons of an increased security of supply as well as for economical reasons. The various technical possibilities for the production of line-dependent secondary energy carriers are being demonstrated. Following this, it will be pointed out that the long lead times required for these technologies necessitate an expeditious and energetic pursuance of adequate developments even today. Finally it will be shown at what rates an implementation of the different technologies is possible.

12271 (Juel-Conf—23, pp 187-206) **Hydrogen production using nuclear energy perspectives and applications.** Beghi, G. (Commission of the European Communities, Ispra (Italy)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The present contribution is limited to the quotation of the keywords and the graphical representations of the lecture.

12272 (Juel-Conf—23, pp 122-127) **Some technical and economical aspects of the nuclear heat power plant and the heat transport system.** Salminen, P. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Saehkoeteknillen Lab.). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session B: nuclear district heating and low temperature applications.

Starting from the estimated development of the electricity and heat demand in Finland until the year 2000, economic aspects of the application of nuclear energy in nuclear thermal power plants instead of conventional energy carriers (already used in Finland) are investigated. The essentiel factor in it is the distance of heat transmission.

12273 (NP—22470) **Regional factors in planning and siting electrical energy facilities in the western states.** (Western Interstate Nuclear Board, Lakewood, Colo. (USA)). 5 Apr 1977. vp. NTIS.

A summary of a study directed at identifying the problem in planning and siting nuclear and other electrical energy facilities in the Western Interstate Nuclear Board region is presented.

12274 (ORAU/IEA(M)—76-3) **Cost comparison between baseload coal-fired and nuclear plants in the midterm future (1985—2015).** Phung, D.L. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Sep 1976. Contract EY-76-C-05-0033. 34p. Dep. NTIS, PC A03/MF A01.

The purpose of this study is to examine the relative costs of the coal and nuclear modes of electricity generation in the period between 1985 and 2015. These two modes of power generation are likely to be the mainstay source of electric power in the United States for that time period. A thorough understanding of their competitiveness not only is important in utility companies' decisions to go one route or the other but also is important to the government and the public when answers must be found for difficult questions, such as economic and environmental implications of a massive societal leaning toward one or the other option. In this study, the primary and secondary factors that affect the cost comparison of coal-fired and nuclear plant options for the midterm future have been separated and arranged so that they can be examined systematically. Estimated inflation of the economy and net fuel cost increases are internalized in the determination of life-cycle levelized cost of electricity in several plausible scenarios. Baseline data for capital and operating costs at beginning-of-life are determined by the tax rate, the expected rate of inflation at the time of capitalization, the net rate of fuel cost increases, and future eventualities of inflation. Other factors such as plant life spans, capacity factors, changes in baseline capital, and fuel cost are considered in sensitivity studies.

12275 (PB—272081) **U.S. commercial nuclear power: a status report.** Cleark, R.G.; Reynolds, A.W. (Federal Energy Administration, Washington, D.C. (USA); Smithsonian Science Information Exchange, Inc., Washington, D.C. (USA). Current Cancer Research Project Analysis Center). Sep 1977. 32p. (FEA/B—77/390). Dep. NTIS, PC A03/MF A01.

The current and forecasted status of the domestic nuclear power program is discussed in the context of the proposed National Energy Plan. Nuclear power is expected to increase its contribution to the Nation's electricity generation from 9.4 percent in 1976 to 13 percent in 1980 and 18 percent in 1985. Indigenous uranium reserves and resources appear adequate to allow a continued expansion of the national reactor system, but the annual production capacity of the domestic uranium industry must be significantly expanded to support this generating forecast. U.S. uranium enrichment capacity will also be adequate if ongoing expansion programs and the planned Portsmouth centrifuge addition are realized. However, domestic uranium demand and price, and the Administration's desire to accept new orders for enrichment services, are sensitive to Energy Research and Development Administration's enrichment contract stipulations and plant operating modes. Current U.S. policy has resulted in the deferral of the plutonium and uranium recycle option for the intermediate future, and a shift in post-reactor attention from reprocessing-recycle to unresolved programs for spent fuel storage and radioactive waste management. The comparative economics of nuclear-fueled and coal-fired generating systems vary among geographical regions, but generally, costs are so similar that modest changes in fuel or operating parameters could reverse the relative advantage of one option over the other.

12276 **Choice of thermal reactor systems. A report by the National Nuclear Corporation Limited, published by the Secretary of State for Energy on 29th July, 1977.** *Atom (London);* No. 251, 207-213(Sep 1977).

Extracts are presented, by the Secretary of State, from the Thermal Reactor Assessment Report which was prepared by the National Nuclear Corporation (NNC) in order to assist in the decision of choice of a thermal reactor for the UK. The extracts show some of the NNC's main conclusions and summarise the attributes of the three reactors studied, i.e. SGHWR, AGR and PWR. The main features of the assessment are presented in an appendix which is abstracted from the 200 page summary of the report and concern those points most relevant to the choice of reactor, i.e. safety, security of the investment, operational characteristics, development and launching requirements, effect on industry, and capital and generation costs. It is concluded that there is now no case for adoption of the SGHWR, leaving the choice between the PWR and the AGR. The options this leaves are set out and include the choice of adopting the PWR whilst continuing with the AGR. To achieve the principal purposes of such a two system choice, would require the early adoption of the PWR with supporting domestic ordering and development work programmes whilst ordering and building an AGR station in such a way as to help rather than hinder the UK export capability.

12277 **Energy prices and the role of nuclear power.** Brookes, L.G. (UKAEA London Office). *Atom (London);* No. 250, 171-178(Aug 1977).

This is a paper by a member of the Economics and Programmes Branch of the United KIngdom Atomic Energy Authority. It is presented under the following headings: conventional view of the energy problem and an alternative view; energy costs and prices; and the role of nuclear energy. The author states that there is a widespread but by no means universal belief that the world energy problem will be solved by rising prices, but he rejects this view. He contends that high prices are the problem and not the solution. Supply and demand will be brought into balance at some price, and the objective of energy policy should be to make this price as low as possible by concentrating on the exploitation of large, low-cost energy sources.

12278 **Economic and resource aspects of fast reactors.** Iliffe, C.E. *Atom (London);* No. 250, 163-170(Aug 1977).

This is a paper by the former head of the Central Technical Services, UKAEA Reactor Group, Risley, presented under the following headings - characteristics of fast reactors; comparison of electricity generating costs for thermal and fast reactors; national

energy requirements; nuclear power in the UK; and the need for the fast reactor.

12279 Coal and nuclear power: a reply to Leslie Grainger. Nicholson, R.L.R. (UKAEA London Office). *Coal, Gold Base Miner. South. Afr.;* No. 14, 31-38(Aug 1977).

Reference is made to a previous publication (Grainger, Coal and Energy Quarterly; 12:9 (1977)) which called for a total reappraisal of the role of nuclear power and for a development programme reoriented to new objectives. This article concludes, however, that the nuclear industry (in the UK) needs a consistent policy of ordering and reactor design; that the fast reactor must go ahead; and, that by the end of the century, coal and nuclear energy will have to be used to their economic limits to avoid high energy prices creating national instability.

12280 Finns and Swedes announce results of joint study on underground plant. Nilsson, L. (ASEA-ATOM AB, Vaesteraas (Sweden)); Hannus, M. *Nucl. Eng. Int.;* **22**: No. 261, 50-52(Aug 1977).

The concept SECURE (Safe Environmentally Clean Urban Reactor) is the result of a joint Finnish-Swedish study into the technical and economic aspects of a low temperature nuclear district heating plant. The project encompasses the preliminary design and safety analysis of a 200 MWth plant with an outgoing temperature to the heating system of 95°C. Essential safety features are underground siting, shutdown and core cooling assured in all accident conditions, no operator action required subsequent to a accident, and low power density resulting in low fission product release. Details are given of the reactor, the shutdown and cooling systems, station layout, and main parameters.

12281 Nuclear energy transfer and politics. Report on the AEOI/ANS/ENS/JAES conference on the transfer of nuclear technology in Persepolis. Nentwich, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Internationales Buero/Uebersetzergruppe). *Atomwirtsch., Atomtech.;* **22**: No. 7, 380-381(Jul 1977). (In German).

From Conference on transfer of nuclear technology; Shiraz, Iran (10 Apr 1977).

More than expected before its beginning, the Persepolis conference became a forum for the countries on the threshold to the nuclear age, who articulated their plans for cooperation in an unequivocal way. Interesting technical-scientific and economic contributions were overshaded by nuclear politics which received special momentum by the proclamation of the new American nuclear policy immediately before the conference. All participants were in accord with regard to the necessity of realizing non-proliferation and appropriate safety controls, but without discrimination.

12282 New U.S. nuclear policy. Patermann, C. (Botschaft der Bundesrepublik Deutschland, Washington, D.C. (USA)). *Atomwirtsch., Atomtech.;* **22**: No. 7, 382-385(Jul 1977). (In German).

Never before has the assumption of office of a new U.S. president been associated by the interested public with so many negative or positive expectations, depending on personal opinions, with respect to the national and international peaceful utilization of nuclear power as in the case of Jimmy Carter. These anticipations, which had thriven also on statements made during the election campaign, were put on more solid foundations by President Carter's declaration on nuclear policy of April 7, 1977, his general declaration on energy policy of April 20, 1977, and the first introduction by the administration of a comprehensive piece of legislation on nuclear exports on April 27, 1977. Major decisions include the indefinite postponement of commercial reprocessing and of the development of LMFBR's. On the other hand, the further development of nuclear power was advocated, especially through the use of light water reactors. It is very difficult to arrive at a sober assessment of the longer term consequences of U.S. nuclear policy. A consensus among the supplier countries with respect to export restrictions will have to take into account worldwide realities to a greater extent than had originally been anticipated.

12283 Cost of nuclear power stations; comparison test between France and the United States. Gauzit, M.; Fuhrmann, R. (Novatome Industries, 92 - Le Plessis-Robinson (France)). *Rev. Gen. Nucl.;* No. 1, 39-46(1977). (In French).

A comparison, even if roughly made, between the investment costs of nuclear power stations quoted in literature for France and the United States cannot be made with certainty. While in the United States the amounts correspond to the total expense in standard currency, in France they are applicable only to an estimate intended to justify a development at the level of national planning by comparing its profitability with different schemes (coal power stations, hydraulic plants, or new energies). It is shown how the shift of a factor close to 2 between two amounts found in the literature is due to different accounting practices that have been taken into account and to the differences in the inflation rates.

12284 How is nuclear power going. Hilding, S.O. *Suvrem. Med.;* No. 569, 20-37(1977). (In Swedish).

This is a popular account of the state of nuclear power, with particular reference to Swedish installations. The utilisation factors of nuclear, hydroelectric, and oil-fired power stations are compared, with some reference to their economics. Some details are given regarding the operating experience of Swedish nuclear power stations.

12285 Survey of the French-nuclear industrial pattern. Robatel, M. (Robatel-S.L.P.I., 69 - Lyon (France)). *Rev. Gen. Nucl.;* No. 1, 50-55(1977). (In French).

The French nuclear industry would have never been unable to attain such a development as the present one without the existence and efforts, besides huge companies and industrial groups, of a group of medium or small scale companies specialising in one or several fields, sometimes very limited. A survey of these small and medium sized companies is established. Based on well defined exemples, in an obviously incomplete way, the part they took and the problems they had to cope with when entering the nuclear industry are described.

12286 Is rapid development of nuclear power purposeful. *Trend, Prognosticke Inf.;* **9**: No. 1, 20-21(1977). (In Czech).

The questions of the development of nuclear energy are discussed with regard to the efficacy of investments. The results are given of studies carried out at the nuclear research institute in Juelich in the FRG. At the estimated 25 years' service-life of the reactor and 0.2% uranium concentration in ore the following results were obtained: Total energy consumption for the construction and operation of a light water reactor power plant makes up 4.6% of the total power production, and in high-temperature reactors it amounts to 3.5%, both with uranium enrichment by the diffusion process. In uranium enrichment by centrifugal technology, consumption drops to 1.25% for LWRms and to 0.9% for high-temperature reactors, in fast breeder reactors it makes up only 0.8% of the total power production of the nuclear power plant. The period during which a nuclear power plant produces the amount of power consumed in construction and operation is 1.2 to 2.5 months which makes it less costly and more economical than any power plant burning coal minus the negative environmental impacts of such power plants.

FUEL CYCLE

12287 Fuel cycle analysis of heavy water-moderated reactor system. Paik, I.K.; Kim, J.S.; Lee, C.K.; Chung, C.H.; Kim, C.H. *J. Korean Nucl. Soc.;* **9**: No. 1, 15-31(Mar 1977).

New conception of batch and period is defined appropriate for the on-power refuelling scheme of a heavy water-moderated reactor. A computer code ("HWRCOST") is developed using nuclear fuel cycle economic equations based on the continuous energy calculation method. The fuel cycle cost of the CANDU-PHW reactor is calculated and sensitivity analyses are performed with variation of uranium ore price, fabrication cost, spent fuel permanent disposal expenses, and capacity factor.

12288 Principle of nuclear fuel cycles. Rauch, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna); Schneeberger, M. (Kernkraftwerk-Planungsgesellschaft m.b.H., Vienna (Austria)). *Elektrotech. Maschinenbau;* **94**: No. 2, 70-82(Feb 1977). (In German).

The article presents a critical review of the present technological position of nuclear fuel cycles; it deals with general ideas and basic principles, the commoner current types of generating station reactors (giving inter alia the basic data of their performance), the formation of isotopes and the changes in fuel characteristics during irradiation, characteristic data on fuel cycles and recycling processes, fuel regeneration, and handling of waste products.

12289 Fuel circuit, problems and conclusions. Clauss, J. (Badenwerk-Energ-Versorg Schwaben, Karlsruhe, Ger). *At. Strom;* **21**: No. 7-8, 73-74(Jul-Aug 1975). (In German with English abstract).

The author reports on the lecture session "Fuel Elements, Fuel Circuit and Isotope Technique" of the 1975 Reactor Conference from the point of view of electric supply undertaking. With increasing consolidation in nuclear energy engineering the emphasis is being shifted more to that part of the fuel circuit which is outside the power plant: natural uranium and separation process supply as well as fuel element treatment and discharge prevention.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 11796, 11797

12290 (Juel-Conf—23, pp 114-121) **District heating reactor THERMOS.** Lerouge, B. (Societe Technique pour l'Energie Atomique (Technicatome), Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Dec 1976. (In French).

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session B: nuclear district heating and low temperature applications.

Based on good operational results obtained from 5 French pool-type research reactors the author suggests the use such a type with a power of 100 MW for the production of heat for district heating. The information on engineering data is supplemented by a short discussion of safety aspects. In comparison with conventional heating plants, the advantages of this kind of energy conversion are pointed out.

12291 (Juel-Conf—23, pp 32-42) **Process steam applications, U.K. studies.** Main, F.K.; Richards, J. (Programmes Analysis Unit, Chilton (UK)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industral processes.

After reviewing the energy consumers' structure in the U.K., the authors investigate the marketing chances for the nuclear process steam production. The most important economic parameters in this study are the demand diversified according to geographically oriented centers of consumption, as well as the cost of steam transmission. Here, too, economy depends on the cost resulting from the application of other energy carriers, and in order to ensure it, further detailed investigations are neccessary.

12292 (Juel-Conf—23, pp 17-31) **Steam production by a water reactor of the C.A.S. type.** Martinot, G. Dec 1976. (In French).

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industrial processes.

In the present paper, a PWR reactor of small to medium power is presented having been developed in a joint effort by CEA and TECHNICATOME. It mainly serves for process heat production and is to be used for district heating and in the field of sea water desalination.

12293 (Juel-Conf—23, pp 207-217) **High temperature reactor HTR as the nuclear heat source for the production of nuclear hydrogen.** Barnert, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The motivations for research and development work in the field of production of hydrogen from water, using heat from the high temperature reactor HTR are given. The concept of the nuclear hydrogen economy is explained. Thermodynamical calculations and preliminary optimizations with respect to the maximum process temperature of a thermochemical cycle are summarized with the result that the production of HTR heat with maximum gas outlet temperature of 1,000°C to 1,100°C is feasible with the today existing HTR technology. The nuclear reactors AVR, THTR 300, PR 500 and Pr 3,000 are briefly described.

12294 (Juel-Conf—23, pp 65-76) **Nuclear process heat for the steel industry.** Barnes, R.S. (British Steel Corp., London). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industrial processes.

There are various possibilities for using nuclear process heat from a high temperature reactor to reduce iron ore, each using different proportions of nuclear energy. The advantages in separating the high temperature reactor with its associated reducing gas producer from any steel complex, include the ability to supply such gas to other consumers additional to the steel industry. The potential for nuclear gas-producing complexes in Western Europe is discussed as is the need for appropriate co-operation in the considerable research that will be needed to bring this new technology about.

12295 (Juel-Conf—23, pp 77-82) **Zinc- and aluminium making processes using HTGR process heat.** Huwyler, S.; Seifritz, W.; von Kaenel, B. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industrial processes.

The high temperature gas-cooled reactor (HTGR) has frequently been suggested as a source of process heat for steel-making; now it has been suggested that it could also be used in the zinc- and aluminium-making processes. For that purpose, several procedures are proposed whereby the key steps in the reduction of zinc oxyde are the use of a gas produced and heated by the HTGR process heat source. Also for the aluminium making process a series of new techniques in connection with the Toth and Grothe processes, coupled to a HTGR, are discussed.

12296 (Juel-Conf—23, pp 43-64) **High temperature reactors for gasification and liquification of coal.** Kugeler, K. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session A: nuclear energy for industrial processes.

To begin with, the lecture explains the coupling of the helium-cooled high-temperature reactor with hydrogasification and steam gasification of coal as well as coal liquefaction; it then deals with the current state of technology of pebble-bed reactors and their application as producers of process heat, illustrating two design variants of a 3,000 MW(th) process steam reactor with integrated and non-integrated steam reformer. Furthermore, the current R + D work concerning the steam reformer, the intermediate heat-exchanger, hydrogasification, and steam gasification of coal are mentioned. Additional information refers to cost estimation, market potential, and development program.

12297 (Juel-Conf—23, pp 155-163) **Transport of chemical bound energy.** Schulten, R.; von der Decken, C.B.; Kugeler, K.; Barnert, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session C: new energy carriers and systems.

The oil crisis has manifested that it is necessary to use nuclear energy to an increasing extent for purposes of energy supply and, particularly, for the supply of the non-electric energy market. This purpose is served by the energy supply system 'Nuclear Energy over Long Distances', by which nuclear energy is transported in a converted form and transformed into the applicable forms of energy such as hot water or water vapour and electricity. The energy transport involves the transport of the 'latent heat gas' which by chemical reaction will be absorbing or emitting thermal energy. The latent heat gas 'synthesis gas/methane' presents a few substantial advantages. The nuclear heat source of the energy supply system 'Nuclear Energy over Long Distances' is the high-temperature reactor.

12298 (Juel-Conf—23, pp 131-137) **Water desalination plant as a complementary part for a nuclear district heating system.** Salminen, P.; ElMahgary, Y.; Ranne, A. (Valtion Teknillinen Tutkimuskeskus, Otaniemi (Finland). Saehkoeteknillen Lab.). Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session B: nuclear district heating and low temperature applications.

Various possibilities of coupling electricity, heat (district heating), and fresh water (desalination) production in multi-purpose plants working as nuclear power plants are discussed. Some principles of cost optimization are described.

12299 (ORNL/TM—5881) **Assessment of a small pressurized water reactor for industrial energy.** Klepper, O.H.; Fuller, L.C.; Myers, M.L. (Oak Ridge National Lab., Tenn. (USA)). 4 Oct 1977. Contract W-7405-ENG-26. 51p. Dep. NTIS, PC A04/MF A01.

An evaluation of several recent ERDA/ORNL sponsored studies on the application of a small, 365 MW(t) pressurized water reactor for industrial energy is presented. Preliminary studies have investigated technical and reliability requirements; costs for nuclear and fossil based steam were compared, including consideration of economic inflation and financing methods. For base-load industrial steam production, small reactors appear economically attractive relative to coal fired boilers that use coal priced at $30/ton.

12300 **Process plant.** Coast, G.; Briody, R.F. (to United Kingdom Atomic Energy Authority). US Patent 4,046,630. 6 Sep 1977. Priority date 15 May 1975, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

To supply process heat to a number of discrete reaction zones typically of a methane reformer plant, the hot gas from a nuclear reactor is employed. The reaction zones are defined within the bores of process tubes and heat is applied by way of gas conduits co-axial with the tubes. The reactants and heating gas are passed in counter current from header pipes which are coupled to the process tubes by flexible pipes. The latter are crushable to isolate any particular process tube, e.g., for replacement of catalysts, etc.

12301 **Nuclear steam turbines for power production in combination with heating.** Frilund, B.; Knudsen, K. (Stal-Laval Turbin AB, Finspong (Sweden)). *Nucl. Eng. Int.;* **22**: No. 261, 53-55(Aug 1977).

The general operating conditions for nuclear steam turbines in district heating system are briefly outlined. The turbine plant can consist of essentially the same types of machines as in conventional district heating systems. Some possible arrangements of back-pressure turbines, back-pressure turbines with condensing tails, or condensing turbines with heat extraction are considered for nuclear power and heat stations. Principles of control for hot water temperature and electrical output are described. Optimization of the plant, considering parallel variations during the year between heat load, cooling water temperature, and required outgoing temperature is discussed.

12302 Most promising area of future nuclear heat utilisation. Raisic, N. (International Atomic Energy Agency, Vienna (Austria)). *Nucl. Eng. Int.;* **22**: No. 261, 41-45(Aug 1977).

The next two years should see decisions made on whether or not to proceed with large demonstration projects of nuclear district heating systems in Czechoslovakia, Denmark, West Germany, Finland, France and Sweden. A number of issues still have to be resolved before widespread use of such heating becomes practicable. The present status of the use and the technology of district heat is outlined. Reference is made to issues of safety, coolant media, transmission, distribution and storage of heat, and also to problems of organization. Some of the existing economic and technical uncertainties in evaluating nuclear district heating systems are mentioned.

12303 Small-size CAS 3 G PWRs can give combined production of hot water and power. Raoul, J.P.; Barbarit, H. (Alsthom-Atlantique (France)). *Nucl. Eng. Int.;* **22**: No. 261, 55-57(Aug 1977).

The use of CAS 3 G pressurised water reactors for district heat applications is discussed. These reactors are specially designed to operate in small supply systems. Heat can be produced in a closed cycle while power is generated as a by-product in a back-pressure turbine. Particular attention is paid to the reliability and ease of maintenance. Main parameters of the fuel and the steam supply system are listed and the secondary steam water cycle is described. An illustration is given of how the plant may be installed on existing heating systems.

12304 Four steps to nuclear district heating. Schwarz, T. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). *Nucl. Eng. Int.;* **22**: No. 261, 45-49(Aug 1977).

District heating from nuclear power plants in combination with gas turbine heat plants is described. Various heat-cycle arrangements are compared in a standard KWU 1300-MWe nuclear plant, with special consideration given to the most economical solution.

12305 Nuclear urban central heating. Ricateau, P. (CEA, 75 - Paris (France). Dept. des Programmes). *Rev. Gen. Therm.;* **16**: No. 184, 345-355(Apr 1977). (In French).

The new economic conditions lead to study heat production by means of nuclear reactors to supply urban centers. Heat production can be achieved by power stations (with or without change). Optimization of the heat production, hot water transportation, and supply design is investigated. Heating can also be obtained by specialized reactors (heat-generating reactors and pool reactors). The nuclear urban central heating development conditions (urban center requirements, urban central heating networks) are studied.

12306 Deriving heat from large power-station units. Korek, J. (KA-Planungs G.m.b.H., Heidelberg (Germany, F.R.)). *Fernwaerme Int.;* **6**: No. 3, 101-105(1977). (In German).

From 7. annual meeting and discussion meeting with 2. district heating exhibition of the Arbeitsgemeinschaft Fernwaerme e.V. (AGFW) at the VDEW; Duesseldorf, Germany, F.R. (2 - 4 May 1977).

One of the aims of district-heating economy is to present heating costs favourably and this is best achieved by deriving heat from large power-station units. At the same time the requirement for a considerable reduction in the consumption of primary energy is also satisfactorily met. For hot water as the heating medium the author presents the narrow temperature limits on design which result when low heating costs are aimed at. On this basis he gives a systematic arrangement of the possible means of deriving heat in dependence on amount of heat tapped off. The author differentiates between fossil-fuel and nuclear power stations. The dependence of the power losses on the corresponding parameters is clearly shown in numerical data and diagrams which give information on the layout of large district-heating systems.

12307 Simplified reactor for sea water desalination. Ronen, Y.; Goldfeld, A. (Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Nuclear Engineering). *Ann. Nucl. Energy;* **4**: No. 4, 183-184(1977).

A very brief review is given of single-purpose desalination plants heated by nuclear reactors. Reference is made to some existing projects and to two new concepts recently developed in Israel. The first of these is the aluminium tube multi-effect (ATME): a 1 MGD ATME plant is now in operation and a 10 MGD one is being designed. The other is the direct contact condensation (DCC) plant: a 50,000 GPD pilot plant is under construction at Haifa. Both concepts are characterised by economy and operating temperatures below 100°C, the use of simple water-cooled reactors without pressure vessels or tube, and cheap construction materials.

12308 Nuclear process heat: hydrogenation and cracking reactions. Bedenig, D. (General Atomic Europe, Zurich). *Erdoel-Erdgas Z.;* **91**: No. 11, 395-401(1975). (In German).

A discussion covers the technology of high-temperature gas-cooled reactors and the basic principles of coal gasification by steam reforming.

NUCLEAR REACTOR TECHNOLOGY

REFER ALSO TO CITATION(S) 12825

12309 (INIS-mf—3663) **Transactions of the Nuclear Societies of Israel. Vol. 4.** (Israel Nuclear Society, Yavne; Israel Health Physics Society; Radiation Research Society of Israel; Israel Society of Medical Physics; Israel Society of Nuclear Medicine). 1976. vp. (CONF-761249—). NTIS.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

Each paper has been separately processed for the Energy Data Base. (DG)

12310 (RISO-M—1931) **Department of Reactor Technology: annual progress report 1 January - 31 December 1976.** (Risoe National Lab., Roskilde (Denmark)). Jun 1977. 59p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The work of the Department of Reactor Technology within the following fields is described: reactor engineering, structural reliability, system reliability, radiation fiels in nuclear power plants, reactor physics, fuel management, fission product decay analysis, steady-state thermo-hydraulics, reactor accident analysis for LOCA and ECC, containment analysis, experimental heat transfer, reactor core dynamics and power plant simulators, control rod ejection accident analysis, economic studies for power plants, experimental activation measurements and neutron radiography at the DR 1 reactor.

THEORY AND CALCULATION

12311 (AAEC/E—410) **AUS module MIRANDA - a data preparation code based on multiregion resonance theory.** Robinson, G.S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1977. 83p. Dep. NTIS (US Sales Only), PC A05/MF A01.

MIRANDA is a data preparation module of the AUS reactor neutronics scheme and is used to prepare multigroup cross-section data which are pertinent to a particular reactor system from a general purpose multigroup library of cross sections. The cross-section library has been prepared from ENDF/B and includes temperature dependent data and resonance cross sections represented by subgroup parameters. The MIRANDA module includes a multiregion resonance calculation in slab, cylinder or cluster geometry, a homogeneous Bsub(L) flux solution, and a group condensation facility. Interaction with other AUS modules, particularly for burnup calculations, is provided.

12312 (CNEN-RT/FI—77-2) **Heterogeneous computation tests of both substitution and reactivity worth experiments in the RB-3 reactor.** Broccoli, U.; Cambi, G.; Vanossi, A.; Zapellini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1977. 45p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This report presents the results of several experiments carried out in the D_2O-moderated RB-3 reactors at the CNEN's Laboratory of Montecuccolino, Bologna. The experiments referred to are either fuel-element substitution experiments or interstitial absorber experiments and were performed during the period 1972-1974. The results of measurements are compared with those obtained by means of computational procedure based on some "cell" codes coupled with heterogeneous codes.

12313 (GKSS—77/E/8) **Physics of feed back process in nuclear rectors. Lectures of a technical meeting of the KTG-Fachgruppe Reaktorphysik on 22nd and 23rd January 1976 at the research center Geesthacht.** Buenemann, D. (ed.). (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1977. vp. (In German). (AED-Conf—76-113-002; CONF-760143—). NTIS.

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976).

Each lecture presented at the meeting has been separatley processed for inclusion in the data base. (HDR)

12314 (GKSS—77/E/8, pp 7-11) **Current questions about feedback effects in thermal reactors.** Buenemann, D. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976).

In Physics of feed back process in nuclear reactors.

The present paper deals with transforming 3d-distributions to reactivity values of point kinetics and with space - and time-dependent feedbacks - not determinable by point kinetics - distinguishing in each case between nuclear (Xenon, Doppler) and thermohydraulic effects.

12315 (GKSS—77/E/8, pp 64-92) **Feedback phenomena in nuclear reactors.** Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976).

In Physics o feed back process in nuclear reactors.

It is investigated what influence the thermodynamic behaviour of the steam dome of a reactor with pressure autocontrol has on the dynamics of the reactor system. For automatic control, either the circuit water must be thermally coupled with the steam dome or, without coupling, there must be a sufficiently large subcooling of the reactor core. The coupling mechanisms between water and steam in the steam dome to be considered are heat conduction, boiling, and condensation. A heat sink in the steam dome enforces a thermodynamic equilibrium between water and steam and provides good autocontrol properties. Without a heat sink, thermal heat coupling is ended when the pressure rises. Nevertheless, with direct contact between circuit and steam dome the reactor remains controllable. At the reactor of the NCS-80, where the circuit is separated from the steam dome by a buffer volume, autocontrol takes place with a heat sink in the steam dome and with sufficient shifting of the working point into the subcooled region caused by the rising of bubbles.

12316 (IAE—2578) **Users quide for the 'HODIHER' program for heterogeneous reactor calculation.** Gorodkov, S.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. 24p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The users guide for the HODIHER program of heterogeneous reactor calculation is described. Two-dimensional heterogeneous reactor is represented as a finite or infinite assembly in the infinite moderator, which is covered by a square lattice. It is assumed that the medium in each cell is homogeneous and the neutron transport in such a reactor is described by a two-group diffusion equation. The five-point finite-difference scheme is applied for solving diffusion equations. The HODIHER program is designed for the BESM-6 computer. The program is written in FORTRAN.

12317 (Juel—1370) **Program for computing the optimal xenon control.** Kaussen, R.D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralinstitut fuer Angewandte Mathematik). Dec 1976. 61p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

A program for computing the optimal control of xenon oscillations of a one dimensional slab reactor is given. The optimal control problem is formulated as a minimization problem of an integral functional. A strategy is developed which makes it possible to calculate minimal values for the positioning and strength of the control rods approximating the optimal parameters such that excessive calculations are avoided. The resulting program is presented and described. An illustrative example demonstrates the efficiency of the program.

12318 (LA—6931-PR) **Reactor technology. Progress report, April—June 1977.** Warren, J.L. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1977. Contract W-7405-ENG-36. 50p. Dep. NTIS, PC A03/MF A01.

Progress is reported in eight program areas. Steady progress has been made on defining the design of Space Electric Power Supply (SEPS) components. There have been three significant advances in heat pipe technology. Criteria have been set forth for the selection of compatible combinations of ceramics and metal coats for heat pipes. A system to avoid molecular absorption of the laser light in sodium vapor lasers was devised and tested. A mercury heat pipe to remove heat from stored fuel elements is being fabricated. Work continues on the evaluation of computer codes used in the analysis of gas-cooled nuclear reactors to be used for nuclear process heat. Work is nearly complete on a model of a Gas Core Reactor Power Plant. Criticality experiments are being run in the Plasma Core Critical Assembly. Several other critical assemblies are in routine use for verifying calculations and supporting research being done by other groups in the Laboratory. Several criticality safety studies and reviews were made. Work has begun on a proposal for developing an Electro-Nuclear Fuel Producer (ENFP).

12319 (LA—6941-MS) **Standard interface files and procedures for reactor physics codes. Version IV.** O'Dell, R.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 78p. Dep. NTIS, PC A05/MF A01.

Standards, procedures, and recommendations of the Committee on Computer Code Coordination for promoting the exchange of reactor physics codes are updated to Version IV status. Standards and procedures covering general programming, program structure, standard interface files, and file management and handling subroutines are included.

12320 (LA-NUREG—6713) **Decay heat from products of ^{235}U thermal fission by fast-response boil-off calorimetry.** Yarnell, J.L.; Bendt, P.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 37p. Dep. NTIS, PC A04/MF A01.

A cryogenic boil-off calorimeter was used to measure the decay heat from the products of thermal-neutron-induced fission of ^{235}U. Data are presented for cooling times between 10 and 10^5 s following a 2×10^4 s irradiation at constant thermal-neutron flux. The experimental uncertainty (1 sigma) in these measurements was approximately 2 percent, except at the shortest cooling times where it rose to approximately 4 percent. The beta and gamma energy from an irradiated ^{235}U sample was absorbed in a thermally isolated 52-kg copper block that was held at 4 K by an internal liquid helium reservoir. The absorbed energy evaporated liquid helium from the reservoir and a hot-film anemometer flowmeter recorded the evolution rate of the boil-off gas. The decay heat was calculated from the gas-flow rate using the heat of vaporization of helium. The calorimeter had a thermal time constant of 0.85 s. The energy loss caused by gamma leakage from the absorber was less than or equal to 3 percent; a correction was made by Monte Carlo calculations based on experimentally determined gamma spectra. The data agree within the combined uncertainties with summation calculations using the ENDF/B-IV data base. The experimental data were combined with summation calculations to give the decay heat for infinite (10^{13} s) irradiation.

12321 (LIYF—226) **Programs for reactor calculations in one-dimensional diffusion-group approximation.** Erykalov, A.N.; Kotova, L.M.; Smirnova, T.I. (AN SSSR, Leningrad. Inst. Yadernoj Fiziki). Apr 1976. 34p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

A FORTRAN programme for the BESM-6 computer has been developed for reactor calculation in one-dimension diffusion-group approximation. The programme allows the neutron flux, flux density, multiplication factor or reactor core dimensions to be calculated. The number of mesh points is up to 2230, the calculating areas number which differ in constants or calculating steps is up to 100, the energy group number is up to 3.

12322 (MRR—160, pp 131-147) **Application of nonlinear filter for an estimation of a time-varying reactor parameter.** Tamaoki, T.; Kawano, K. Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

Some parameters among those contained in reactor dynamic equations, have vague true values which change with reactor operating conditions or with an accident, such as channel blockage. For reactor diagnosis, this paper presents a nonlinear filter for use in estimating an unknown time-varying parameter. The criterion for the estimation is the weighted least square error. It is possible to adjust the gain of the parameter estimate so as to always have some non-zero value, by giving an appropriate value to the weight. Accordingly, this filter has parameter tracking ability and requires no knowledge and no restrictive assumption concerning the statistical nature of the random process. This filter has been applied to the point-approximated reactor dynamics model with a temperature feedback. Computer simulations have been made to estimate a time-varying parameter in the feedback system. The results indicate the usefulness of this filter.

12323 (NIIAR-P—263) **Estimation of a statistical error in measuring the reactor period and reactivity in the presence of drift type interference.** Karatsuba, Yu.M. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)). 1976. 13p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

To eliminate the linear drift from an asymptotic power increase, the time difference set, qsub(K), was formed from the neutron detector counts to the K-successive time intervals. The effect of the correlation between qsub(K) - differences on the measuring period error was studied; theoretical errors were obtained which

usually surved as standards when estimating the protection of the detection channel from interferences, the validity of the statistical treatment etc.

12324 (ORNL/TM—6062) **Least-squares dosimetry unfolding: the program STAY'SL.** Perey, F.G. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 69p. (ENDF—254). Dep. NTIS, PC A04/MF A01.

A PDP-10 FORTRAN IV computer program STAY'SL, which solves the dosimetry unfolding problem by the method of least squares, is described. The solution (the output spectrum and its covariance matrix) is calculated by minimizing chi-square based on the input data (the activation data, the input spectrum, the dosimetry cross sections and their uncertainties given by covariance matrices). The solution reflects therefore the uncertainties in all of the input data and their correlations. The correlations among the various dosimetry cross sections are taken into account; however, the activation data, input spectrum and cross sections as classes are assumed to be uncorrelated with each other.

12325 (TUBIK—48) **Neutron physics reactor design illustrated by examples.** Hauptmanns, U. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik). Sep 1976. 114p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Methods of neutron physics reactor calculations are explained by means of small calculational examples. Furthermore a fictitious reactor is designed presenting the calculational procedures in the context of a design calculation. The cell spectra required for collapsing the neutron cross sections are determined using the Ssub(N) method with isotropic and linearly anisotropic scattering and the collision probability method. The differences in effective cross sections and computing time as well as the repercussions on ksub(eff) are given.

12326 Extension of the variation principle and of the generalized perturbation method to the general form of the functionals of a critical reactor. Svarny, J. (Skoda, Plzen (Czechoslovakia). Zavod Jaderne Elektrarny). *Kernenergie;* **20**: No. 9, 274-276(Sep 1977).

A variation functional is derived for a general integral parameter (functional) of a critical reactor. The value of the presented method lies in the fact that this functional and the first order perturbation formulae derived from it cover the whole range of integral reactor characteristics including nonratio ones.

12327 Fine structure measurement of fission density distribution in UO_2 cell using solid state track detector. Narita, M.; Kon, H.; Uematsu, H.; Shoji, I. (Hokkaido Univ., Sapporo (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 1, 65-68(Jan 1977).

Published in summary form only.

12328 Monte Carlo importance sampling technique for resonance escape probability computation. El-Samie Mostafa, A.; Elmeshad, Y.; Aboumandour, M. (Alexandria Univ. (Egypt). Faculty of Engineering). *Atomkernenergie;* **29**: No. 4, 252-254(1977).

A stochastic approach is used for treating resonance escape probability for individual resonances. The technique is based on modifying the actual scattering probability introducing a modifying function which depends on the resonance width and the value of the total cross section at the resonance peak. The dependence is established by performing a computational experiment to determine the optimum parameters of the modifying function which yields maximum efficiency. The optimum parameters are then correlated to the resonance properties; and certain graphical relations are deduced. These relations are a helpful tool that can be used to determine the optimum parameters for any arbitrary resonance.

12329 Time-lethargy equivalence relations in neutron transport theory. Ganapol, B.D.; Henninger, R.J. (Argonne National Lab., Ill. (USA)); Peddicord, K.L. (Richards of Rockford, Inc., Ill. (USA)). *Atomkernenergie;* **29**: No. 4, 247-251(1977).

The equivalent roles of the time and lethargy variables for the following infinite plane geometry transport problems are shown: (1) monoenergetic time-dependent neutron transport in a isotropically scattering homogeneous medium; (2) neutrons slowing down assuming a particular scattering kernel in a medium with constant cross section. This relationship is used to generate an analytic benchmark solution to which the Ssub(N) multigroup transport code ANISN can be compared.

12330 Dependence of material buckling and k/sub infinity/ on the structure of heavy-water-natural uranium metal lattices. Nassar, S.F.; El-Ela, A.A. (Cairo Univ., El Mansura (Egypt). Dept. of Physics). *Atomkernenergie;* **29**: No. 3, 195-198(1977).

A study has been performed on the structural dependence of the material buckling and the infinite multiplication factor of heavy water moderated and cooled lattices having natural uranium metal rods in the form of clusters. The clusters were of the pressure tube type. The study included the effect of the number of rods per cluster, the radius of the single rod, the rod-to-rod distance in the micro-cell, the coolant distribution, and the distance between the elements in the macro-distribution, and the distance between the elements in the macro-cell. These parameters were varied in such a way that kept the power dissipation coefficient and the superficial heat flux constant. It was found that an increase in the single rod diameter and a decrease in the number of rods per cluster result in a better economy of the heavy water inventory and give a smaller critical core size.

12331 (DOE-tr—15) **Natural circulation calculation: single-phase and two-phase flow in pipes.** Gyenes, G.; Csom, V.; Windberg, P.; Toeroek, A. 1977. Translation of KFKI—76-56. 18p. Dep. NTIS, PC A02/MF A01.

In planning the natural circulation of water-cooled reactors one of the most important problems is the accurate determination of the circulation velocity. This problem becomes still more complicated if boiling occurs in some sections of the reactor circuit because the calculation of the two-phase pressure drop is less accurate than that of the single-phase pressure drop, and under certain operating conditions, flow fluctuations may also occur. A bundle consisting of 19 rods was investigated in the Central Research Institute for Physics in a natural circulation loop. This article deals with the natural circulation calculations performed during the preparation of this experiment.

12332 Hidden state-variables and a non-Markoffian formualtion of reactor noise. Nishigori, T.; Kishda, K.; Sekiya, T. (Osaka Univ, Suita-shi, Jpn). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 708-714(Dec 1976).

A non-Markoffian Langevin equation for the fluctuations of known state-variables, f(t), is proposed. The non-Markoffian effect and the new stochastic term $Z(t-t_0)g(t_0)$ are due to "hidden" state-variables g(t). The random force F(t) meets the requirement of the causality conditions, but the random force given by $R(t)=Z(t-t_0)g(t_0)+F(t)$ does not. A new relation between the fluctuation R(t) and the dissipation B(t) is found. The effect of external noise sources is formulated to demonstrate that the present formalism is useful for finding out hidden state-variables. 15 refs.

12333 Optimal control of distributed parameter reactor core by function space method and some numerical experiences. Koga, R. (Kyoto Univ, Gokanosho, Uji-shi, Jpn). *J. Nucl. Sci. Technol. (Tokyo);* **13**: No. 12, 691-700(Dec 1976).

An optimal dynamical control of a linear reactor as a distributed parameter system is obtained numerically along with an analytical expression of the integral equation that should be satisfied by the optimal control. The function space method is employed to derive the equation, and it is known from the numerical experience that only the fundamental of expanding modes are enough to describe the integral kernel of the equation. Space-dependence is collected in the forcing term of the equation. The reactor core model is of two groups of neutrons in steady state and one group of precursors. Two performance functions are tried. Both are quadratic but one is of the precursor history and the control, whereas another is of the neutron flux density and the control. 16 refs.

12334 Effect of a reflector material on the neutron flux in a trap. Bykovskij, V.S.; Zolotov, A.F.; Lantson, M.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). *Vestsi Akad. Navuk BSSR, Ser. Fiz.-Energ. Navuk;* No. 1, 8-11(1976). (In Russian).

Experimental and calculated results are given of the effect of reflector material (Be, graphite, H_20, Zr, steel, Al) on the neutron flux in a trap. Experiments were carried out on a critical assembly of cylindrical shape with replaceable reflectors. A comparison was carried out at the same dimensions and compn. of the active zone. In the experiments themselves, reflectors of Be, H_2O, and stainless steel were used. The quality of the reactor with traps is expressed in parametric form as a function of the ratio of the metal volume to volume of moderator in the active zone. This dependence is illustrated by the calculated results.

12335 Analytic solution for the void fraction during simultaneous linear pressure decay and exponential inlet velocity decay in a diabatic channel. Inayatullah, G.; Nicoll, W.B. (Coll of Eng, Trivandrum, India). *Trans. Can. Soc. Mech. Eng.;* **4**: No. 1, 7-12(1976).

An approximate analytical solution is presented for the spatial and temporal distribution, in a uniformly heated channel, of the void fraction for exponentially decaying inlet velocity and for a linear time-rate of change of system pressure. The reasons for considering this problem were two. First, the exponentially decaying inlet velocity is a reasonable initial approximation to the conditions that prevail in the event of pump failure in a nuclear power reactor; further, the capacity of the present solution to include the effects of vapor generation due to pressure change allows, in addition, a reasonable approximation of the effects of pressure change on the flow and the analytic nature of the solution allows these situations and their consequences to be explored at minimum computation effort and

expense. Second, the present solutions add to the extremely limited number of analytic solutions for nonsteady nonhomogeneous two-phase flows. 9 refs.

12336 Energy-dependent diffusion system in nuclear reactor dynamics. Pao, C.V. (NC State Univ, Raleigh). *SIAM J. Appl. Math.;* **29**: No. 1, 40-59(Jul 1975).

The mathematical problem consists of a system of N+1 coupled partial integro-differential equations in either a bounded or an unbounded spatial domain together with some boundary and initial conditions. This coupled system takes into account the effect of delayed neutrons. It is shown under physically realistic conditions that the coupled initial boundary value problem possesses a unique positive solution which can be constructed by successive approximations. The sequence of approximations, which converges to the true solution, can be determined by using the Green's function, and in some special cases recursion formulas for their calculations are explicitly given. In addition to the existence, uniqueness and the method of construction of a solution, some qualitative analysis, such as the boundedness of the solution and the stability problem of an unperturbed solution, is also given. The same diffusion problem without the effect of delayed neutrons is included as a special case. 18 refs.

12337 Application of albedo equations. Orlov, V.V. *Sov. At. Energy (Engl. Transl.);* **38**: No. 1, 42-43(Jan 1975).

The problem of neutrons reflection from a cylindrical rod is considered the solution of which can be used in formulating the boundary conditions on the surface of reactor control rods. 7 refs.

12338 Dryout measurements in freon 12 in aligned and misaligned 19 rod clusters. Gaspari, G.P. (Cent Inf Studi Exper, Milan, Italy). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-23, 8(1975).

The main conclusions reached in the investigation are: within the limits of experimental error, the dryout power is not substantially affected by the combined effect of cluster discontinuity and misalignment (on the average the differences range within +- 3 percent); angular misalignment leading to preferential discontinuity on the outer rods (15 deg) causes a reduction of dryout power while producing an increase in power if the discontinuity is mainly on the inner rods; freon data and water data for aligned clusters are found to be in complete agreement; and present data show an effect of misalignment which are lower than earlier Canadian data but in the author's opinion are more realistic and representative for practical cases. 17 refs.

12339 Local pressure measurements and peripheral flow visualization in a water 19-rod bundle compared with FLICA II B calculations: influence of helical wire-wrap spacer system. Lafay, J.; Menant, B.; Barroil, J. (Nucl Res Cent, Grenoble, Fr). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-22, 1-12(1975).

An experimental study was performed in a 19-rod bundle using a wire wrap spacer system with water as the working fluid. Local axial and transverse static pressure profile were carefully measured at the wall of hexagonal housing, and the movement of the fluid in the peripheral subchannel was observed during visualization experiments. It was found that the pressure distribution in cross section is not hydrostatic and that the maximum transverse velocity is significantly higher than the value predicted assuming the flow follows the wire wrap angle. The pressure field and the swirl flow induced by wire spacer are strongly dependent of the helicoidal wire location and are periodic with axial position. Experimental results are compared with calculations using the FLICA II B program which includes an elaborate helical wire model. 13 refs.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 12838, 12920

12340 (AE—512) Electrokinetic deposition of waterborne, particulate FeO(OH) and MnO_2 on stainless steel surfaces. Hermansson, H.-P. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Feb 1977. 56p. Dep. NTIS (US Sales Only), PC A04/MF A01.

study forms part of a programme of research into corrosion product behaviour in progress at Aktiebolaget Atomenergi. Attention is in this instance focused on the influence of electrokinetic factors upon the deposition of particulate corrosion products. The work has involved the development of experimental apparatus and techniques and the investigation of the deposition characteristics of FeO(OH) and MnO_2 at temperatures below 100 degC. The experimental results indicate that the deposition rate of the compounds under review depends mainly upon the zeta potential (zeta) of the particle and of the test section wall. The deposition rate attains a maximum when the zeta potential is at a minimum or zero. Deposition occurs when zeta approx. < 40 mV. Outside this interval deposition is not observed. Furthermore, the deposition rate maximum depends upon the rate of change of pH both as regards its magnitude and its position on the pH scale. This dependence can be accounted for in terms of a general drain of material from the loop and a difference in zeta potential between particles and the wall surface of the test section.

12341 (KFK-PDV—103) Mathematical models of power plant units with once-through steam generators. Hofmeister, W.; Kantner, A. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Prozesslenkung mit DV-Anlagen). Jan 1977. 64p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

An optimization of effective control functions with the current complex control loop structures and control algorithms is practically not possible. Therefore computer models are required which may be optimized with the process and plant data known before start-up of thermal power plants. The application of process computers allows additional predictions on the control-dynamic behavior of a thermal power plant unit.

12342 Portable radiography for power plants. *EPRI J.;* **2**: No. 8, 20-22(Oct 1977).

Plans for the development of a miniature radiography apparatus for the in-service inspection of welds and components in nuclear power plants are described.

12343 Steam generating plant. Duval, D.; Taylor, E.H. (to Foster Wheeler Ltd., London (UK)). British Patent 147,6632/A/. 16 Jun 1977. 10p.

Reference is made to integral nuclear reactor steam generating plants. Such plants usually have an annular space between the reactor core and the reactor shell, positioned within which are steam generating tube bundles across which coolant fluid from the reactor core is passed. Owing to the limited space available for the tube bundles, however, it is difficult to locate a sufficient number of tubes in the annular space and to make the tubes of sufficient length to allow production of superheated steam. An arrangement is described that allows location of a considerable number of steam generating tubes within the annular space, the tubes being of sufficient length to allow production of sub-boiling water, boiling water, saturated steam, and superheated steam. All the tubes are substantially the same length and stable steam generating conditions are thus ensured. Constructional details are given.

12344 Determination of testing zones in case of ultrasonic testing with the tandem method. Walte, F.; Werneyer, R.; Horst, B. *Material-pruefung;* **19**: No. 5, 174-177(May 1977). (In German).

For testing thick-walled containers the tandem method is required and applied more and more. An essential problem of the tandem method is the theoretical and experimental determination of the sensitiveness of indication. A model is given for the calculation of sensitivity zones, so-called testing zones. Based on circular disk reflectors vertical to the surface, tandem location curves are calculated. Given parameters are the ultrasound wavelength, size and position of reflector, oscillator dimensions and wall thickness. From these location curves testing zones are determined numerically. These testing zones are extended into three dimensions by inspection of the reflector outside the plane of the acoustic axes.

12345 Two-phase-flow-induced vibrations in a horizontal piping system. Hara, F. (Science Univ. of Tokyo (Japan). Faculty of Engineering). *Bull. JSME (Jpn. Soc. Mech. Eng.);* **20**: No. 142, 419-427(Apr 1977).

The paper deals with experimental and theoretical analyses of the excitation mechanism of vibrations induced by an air-and-water two-phase flow in a straight horizontal pipe. The experiment reveals a strong relationship between the first natural frequency of a piping system and the dominant frequency of void-signals -- that is, the frequency ratio being 1/2, 1/1, 3/2, -- when extraordinarily strong vibrations are observed. The equation of motion in a straight horizontal pipe conveying a two-phase fluid is derived by accounting for 1) inertia force, 2) the pipe's elastic restoring force, 3) Coriolis' force, 4) centrifugal force, 5) pressure fluctuations, 6) momentum change due to time-varying density of the two-phase flow and 7) gravity as an external force. The equation is transformed into a Mathieu's with a periodic external term; instability analysis concludes that parametric excitation and resonance are the main causes of such strong vibrations. Good agreement can be seen between experimental and theoretical results.

12346 Instabilities in parallel channel of forced-convection boiling upflow system, (1). Mathematical model. Aritomi, M.; Aoki, S.; Inoue, A. (Tokyo Inst. of Tech. (Japan). Research Lab. of Nuclear Reactor). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 1, 22-30(Jan 1977).

The instabilities occurring in forced-convection upflow passing through a parallel-channel system have been studied theoretically and experimentally, using water as test fluid. A non-linear mathematical model is proposed that explains the results quite satisfactorily. Close agreement is obtained between calculations based on this model and measurements of the stable boundary in a system of two channels. The model is further applied to three and four parallel

channels, the results of which indicate that the flow instability behavior in such multiple channels is quite similar to that observed in the two-channel system in such aspects as the stable boundary, as well as the period and the development of flow oscillations in the unstable region.

12347 Quality assurance documented. Only high requirements lead to 'good' pipes. Janssen, K. *Hatsuden Suiryoku;* **30**: No. 2, 7(Jan 1977). (In German).

1 fig.

Using Incoloy 800 steam generator pipes as an example, it is shown what quality assurance means to pipe manufacturers and how it is carried out.

12348 Utilizing the power of high steam flow rates with the aid of long end blades. Nuclear power plants and cooling towers promote new developments in turbine construction. Riess, W. *Hatsuden Suiryoku;* **30**: No. 2, 6(Jan 1977). (In German).

Some development problems are illustrated by the example of an end blade with a length of 1044 mm for 50 U/s which is the largest end blade in operation in Germany.

12349 Automated ultrasonic testing--capabilities, limitations and methods. Beller, L.S.; Mikesell, C.R. (EGandG, Idaho, Inc, Idaho Falls). *Am. Soc. Mech. Eng., [Pap.];* No. 77-PVP-16, 1-5(1977).

The requirements for precision and reproducibility of ultrasonic testing during inservice inspection of nuclear reactors are both quantitatively and qualitatively more severe than most current practice in the field can provide. An automated ultrasonic testing (AUT) system, which provides a significant advancement in field examination capabilities, is described. Properties of the system, its application, and typical results are discussed.

12350 Cables for nuclear power generating stations. III. On the properties of cable under design basis event. Ida, M.; Shingo, Y.; Yamaguchi, K.; Sakai, M.; Yatsuhashi, M. (Fujikura Cable Works, Ltd., Tokyo (Japan)). *Fukui Daigaku Kogakubu Kenkyu Hokoku;* No. 55, 57-66(Dec 1976). (In Japanese).

The construction of nuclear power generating stations has been energetically pushed ahead in recent years. In view of the growing importance of providing improved safety measures against possible nuclear reactor accidents, IEEE-STD-383 was established in 1974 stipulating for the implementation of severe environment condition tests based on a presupposed accident at a nuclear power station due to the loss of the reactor coolant and vertical tray flame tests simulating a fire on various types of cables. In Japan, cables for use in nuclear power generating stations have been required to withstand such tests in the wake of enforcement of this rule. The environment condition tests as specified in the regulation is conducted under high temperature and high pressure conditions employing a specially designed pressure vessel. Through intensive researches, new cables with a high degree of resistance to radioactive rays and incombustibility have been developed, demonstrating excellent properties against a series of required tests. Meanwhile, the findings of a study conducted to identify the effect of various processes of an environment condition tests on the sample cable have indicated that the properties of heat-resistant polyvinyl chloride showed a marked degradation during the LOCA process while those of other materials deteriorated remarkably during the process of radioactive rays application.

12351 Clip for reflective insulation. (to Diamond Power Specialty Corp., Lancaster, Ohio (USA)). Netherlands Patent 761,2566/A/. 11 Nov 1976. Priority date 8 Dec 1975, United States of America (USA). 7p. (In Dutch).

A clip is provided for spacing a stack of flanged reflective insulation sheets along an edge of the stack. The clip has a first series of tab members which fit between each sheet of the stack to space the stack, and a second series of tab members which bend over a flanged end of each sheet of the stack to support the stack and prevent the shifting of individual sheets of the stack within the stack. The stacks of reflective insulation sheets are used specifically for nuclear reactors.

12352 Stability analysis of axisymmetric shells by the finite element method. I. Stability analysis in case of axisymmetric loads. Kobayashi, M.; Onodera, S.; Hara, K. (Japan Steel Works Ltd., Muroran, Hokkaido. Muroran Plant). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 362, 3104-3111(Oct 1976). (In Japanese).

Recently, light weight structures have been widely used as machines and structures became large and their performances were heightened, but such structures are apt to present large deformation and instability at relatively low load, therefore the clarification of the problems concerning buckling is an important subject. The present study is intended to solve the linear buckling problems of axisymmetric shells subjected to axisymmetric or asymmetric load and the non-linear buckling problems such as snapping buckling and bifurcation buckling by the finite element method. This paper explains the method of analyzing the linear buckling when axisymmetric load is applied. Axi-symmetric shells are modeled as the assembly of truncated conical shells. Prior to buckling analysis, stress analysis is carried out with usual elastic stiffness matrices. Buckling analysis is carried out by determining the stiffness matrices taking the geometrical non-linearity into account, and solving the equations for the stiffness matrix eigenvalues for the whole system. In order to confirm the property of this analytical method, the computer program was developed, and numerical calculations were carried out for the cylindrical shells subjected to uniform axial compressive load or linearly changing external pressure and the cylindrical vessel with semi-spherical covers at both ends, subjected to uniform external pressure. The propriety and usefulness of this method were proved by the comparison with the results by other methods.

12353 Stability analysis of axi-symmetric shells by the finite element method, (2). Snapping and bifurcation buckling analysis. Kobayashi, M.; Onodera, S.; Hara, K. (Japan Steel Works Ltd., Muroran, Hokkaido. Muroran Plant). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 362, 3112-3116(Oct 1976). (In Japanese).

Generally in case of the buckling of shells, the balanced load lowers rapidly after the buckling, and the maximum values are observed on the load-deflection curves. Snapping buckling occurs and stability is lost often at the much lower load than the theoretical linear buckling load. The buckling of shallow spherical shells is the typical example. In this paper, the method of dealing with the snapping buckling and bifurcation buckling of shells by the finite element method is described. Axi-symmetric deformation is taken into account in the equation for strain and deformation relationship used in this paper so that bifurcation buckling can be treated. Axi-symmetric shells are modeled as the assembly of truncated conical shells, and the equation for basis relation and the stiffness matrices used are same as those in the previous paper. The method of stepwise increasing load is used for the analysis. The eigenvalues of stiffness matrices can be utilized as the critical condition for the stability and instability of systems, accordingly they are analyzed. Taking the example of the buckling of shallow spherical shells subjected to uniform external pressure, snapping buckling and bifurcation buckling were analyzed. The computer program was developed, and the results of numerical calculation by this analysis were compared with the results by other researchers. The propriety of this analytical method was proved.

12354 Crack growth and fracture of the Zr-alloy tubes with an axial crack. I. On the fatigue crack growth of the part-through crack and the through-thickness crack. Shibata, K.; Kawamura, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Atsuryoku Gijutsu;* **14**: No. 3, 127-134(May 1976). (In Japanese).

It is almost impossible to avert stress concentration parts and surface flaws at the time of manufacturing and constructing structures, and fatigue cracks originate and propagate from the stress concentration parts. Accordingly at the time of evaluating the life span of structures, the behavior of crack propagation should be presumed by assuming the possible largest defect. Recently, the fracture mechanics has been developed, and the design method along this line is often adopted. In this study, for the purpose of clarifying the behavior of fatigue crack propagation in Zr-2.5% Nb alloy tubes used for ATRs, fatigue crack propagation test was carried out with Zr-alloy tubes of actual size subjected to internal pressure load. Three shapes of notches, partly penetrating and completely penetrating the tube walls, were tested, and the levels of repeated internal pressure were varied. Crack propagation speed can be represented well by applying the stress intensity factor to the test result. The da/dN- ΔK curves in axial direction in cases of three crack shapes turned out to be almost identical curves irrespective of the stress levels. When the cracks having propagated from small flaws penetrate whole thickness, the crack length on the outside surface was about 13 mm or shorter in this material. Cracks propagated in tension type fracture at first, then shear type fracture arose at a certain crack length irrespective of the stress levels.

12355 Stress analysis of PCV nozzle junction. Uchiyama, S.; Oikawa, T.; Hoshino, S. (Nippon Kokan K.K., Kawasaki, Kanagawa. Technical Research Center). *Atsuryoku Gijutsu;* **14**: No. 3, 113-119(May 1976). (In Japanese).

Most pressure vessels comprise one cylindrical shell and one or more nozzles. In order to analyze the stress in structures of this type, the program for stress analysis by the finite element method was made, which is required for the strength analysis for three-dimensional structures. Especially, the problem of the stress distribution around nozzle junctions was solved theoretically with the program. The program for the analysis is provided with various functions, such as the input generator for cylindrical, conical and spherical shells, and plotter, and is very covenient. The accuracy of analysis is very good. The method of analysis and the calculation of the rigidity matrices for the deformation in plane and bending are explained. The result of the stress analysis around the nozzle junctions of a containment vessel with this program was in good agreement with experimental data and the result with SAP-4 code,

therefore the propriety of the calculated result with this program was proved. Also calculations were carried out on three cases, namely a flat plate fixed at one end with distributed load, a cylinder fixed at one end with internal pressure, and an I-beam fixed at one end with concentrated load. The calculated results agreed well with theoretical solutions in all cases.

12356 Turbines manufactured at the Kharkov turbine generator plant for atomic power stations, and problems which develop during their construction. Kosyak, Yu.F.; Arkad'ev, B.A.; Sukhinin, V.P. *Power Eng.;* **14**: No. 2, 99-109(1976).

The construction of powerful wet-steam turbines fabricated and designed at the Kharkov Turbine-Generator Plant for atomic electric power stations (APS) are described. The paper calls the attention of specialists and scientific teams working in the field of turbine construction and related fields to the necessity of solving the fundamental problems associated with the use of wet steam in turbines, its large volume expenditure, and other characteristic conditions governing the operation of such turbine installations.

12357 Pantograph type refueling machine. Fujita, M.; Suzuki, Y. (to Fuji Electric Co. Ltd., Tokyo (Japan)). Japanese Patent 1976-141,987/A/. 30 May 1975. 5p. (In Japanese).

The object of the invention is to absorb an error in locating a gripper, when fuel is charged or removed, produced due to strain in core and fuel assembly and to secure positive operation. A pantograph operating mechanism of a reactor charging machine is moved up and down within a hold down main guide cylinder through which a rotary plug is extended, and a gripper is moved up and down through a pantograph type link mechanism into engagement with a handling head of the fuel assembly. At this time, an eccentric error between the handling head and the gripper due to strain is absorbed by eccentric following of a gripper guide cylinder, only the upper end of which is secured to a support cylinder.

12358 Clean purge device in a reactor. Yoshimura, K. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-136,100/A/. 17 May 1975. 3p. (In Japanese).

The object is to forcibly pour a part of coolant or cleaning liquid into a place where liquid in a pipe not used is stagnant during normal operation to thereby remove accumulated corrosive products and radioactive materials and at the same time to prevent stress corrosion. A clean purge pipe is disposed between a supply pipe line of a core spray pump on core spray system piping connected to a pressure vessel and a discharge pipe line of a regenerative heat exchanger on coolant purifying system piping, the clean purge pipe being provided thereon with a flow controller, a sluice valve and a check valve or a remote control automatic separating valve.

12359 Auxiliary equipment for cooling water in a reactor. Konno, Y.; Sakairi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-133,691/A/. 16 May 1975. 3p. (In Japanese).

The object is to effectively make use of pressure energy of reactor water, which has heretofore been discarded, to enable supply of emergency power of high reliability and to prevent spreading of environmental contamination. Sea water pumped by a supply pump is fed to a heat exchanger. Reactor water carried through piping is cooled by the heat exchanger and returned to the reactor. On the other hand, sea water heated by the heat exchanger is fed to a water wheel to drive the wheel, after which it is discharged . A generator may be directly connected to the water wheel to use the electricity as the emergency power source.

12360 Reactor fuel renewal means. Kayano, H.; Kage, H.; Joge, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-121,688/A/. 18 Apr 1975. 4p. (In Japanese).

Safety is enhanced at the time of loading of fuel under remote control by providing a bar detection circuit at the time of fuel rod insertion. A load cell for detecting the load on a fuel hoist, a limit switch for determining the insertion of fuel into a reactor core or used fuel rack and a logic determination circuit for effecting logical check of fuel insertion from the outputs of the load cell and limit switch are provided. When the fuel is stacked in the reactor core or used fuel rack the descent of the fuel hoist is stopped by the output signal from the logic determination circuit to thereby prevent the breakage of fuel.

12361 Condensing and water supplying systems in an atomic power plant. Shinmura, A. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-108,199/A/. 20 Mar 1975. 5p. (In Japanese).

The objet is to reduce heat loss and eliminate accumulation of drain in water supplying and heating units in an atomic power plant by providing a direct contact type drain cooler between a gland-exhauster vapor condenser and a condensing and de-salting means, the drain from each water supplying and heating unit being collected in said cooler for heating the condensed water. Condensed water from a condenser is fed by a low pressure condensing pump through an air ejector and gland-exhauster vapor condenser to the direct-contact type drain cooler and is condensed in each water supply heater. Next, it is heated by drain fed through a drain level adjuster valve and an orifice and then forced by a medium pressure condenser pump into the condensing and de-salting means. It is then supplied by a high pressure condensing pump into the successive water supply heater.

12362 Cleaning device for a reactor pressure vessel. Miyakawa, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-105,595/A/. 14 Mar 1975. 4p. (In Japanese).

The object is to effectively remove stagnant cooling water within a pressure vessel and deposits in the bottom of the vessel. A device is provided with a jet pump within a pressure vessel to circulate and clean a coolant in a core, including a number of nozzles for injection of the coolant arranged close to the bottom of the pressure vessel and close to the bottom plate of the jet pump. Injection of coolant causes the deposits to be blown off into an inlet port and guiding into a filtering and desalting unit to remove the deposits. It is to be noted that discharge pressure of the jet pump is utilized as the coolant injection pressure.

12363 Fuel exchanger for a reactor. Kiguchi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-110,193/A/. 7 Mar 1975. 2p. (In Japanese).

The object is to facilitate positioning of a fuel exchange section by mounting the objective lens of a fiber scope at the lower end of a support frame of a fuel assembly. The state of a fuel assembly on top of the reactor core is focused on an eyepiece through the fiber scope by the objective lens at the lower end of a support frame supporting a fuel assembly which is extracted from the fuel exchange section with respect to the reactor core.

12364 Dynamic responses of two parallel circular cylinders in a liquid. Chen, S. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-1, 1-6(1975).

The problem of two parallel circular cylinders vibrating in a liquid is studied analytically. First, the equations of motion including fluid coupling are derived using the added mass concept. Then, a closed form solution and an approximate solution are obtained for free vibration. Finally, the steady-state responses of two cylinders subjected to harmonic excitations are presented. The results of this study illustrate the significance of the interaction of two structures in a liquid. 7 refs.

12365 Stress analysis of main pipework centres of nuclear power stations in Sigma Research Institute. Sima, J. *Czech. Heavy Ind.;* No. 5, 16-22(1975).

To insure the integrity of the primary circuit piping of a nuclear power station which is highly exposed to both mechanical and thermal stresses varying in the course of time, a detailed stress analysis has been carried out. This analysis of the centers of the primary circuit has, fundamentally, two independent stages. The first stage comprises the determination of the behavior of the components of the stress tensor in terms of time, the second stage the determination of the effective tension and the judgement of the centers from the point of view of safety against various kinds of failure.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 12857

12366 Thermocouple pressure bushing in suspension rod. Pasek, J.; Ondreicka, K. Czech Patent 160,319/B/. 15 Oct 1975. 3p. (In Slovak).

The seal is described of jacket thermocouples located in the pressure reducer in the fuel element suspension rod. The thermocouples are sealed in the pressure reducer with a silicon sealing compound. The sealing compound is compressed between the two reducers with a Bellevile spring and a pressure washer secured in position with a spring. The axial pressure of the inner parts of the reducer on the compound is adjustable by means of a thrust screw. The tightness and alignment of the thermocouples in the pressure reducer is achieved by tightening the thrust screw to the stop of the top reducer and the subsequent setting of the sealing compound.

12367 Fuel element design. Chapter 11. MacDonald, P.E. (Idaho National Engineering Lab., Idaho Falls (USA)); Wang, I.-C. (Cincinnati Univ., Ohio (USA)). pp 303-342 of In Elements of nuclear reactor design. Weisman, J. (ed.) (Cincinnati Univ., Ohio (USA). Dept. of Chemical and Nuclear Engineering). Amsterdam, The Netherlands; Elsevier (1977).

The in-reactor behavior of fuel-element materials is considered in this chapter. The application of the principles of mechanical analysis to fuel-element design is then examined in light of this behavior. Since uranium dioxide enriched with small amounts of either ^{235}U or plutonium oxide and encapsulated in metal tubes is the

predominant fuel of present power reactors, this consideration is limited to elements of this general type.

12368 Nuclear fuel rods. Fujibayashi, T. (to Tokyo Shibaura Denki Kabushiki Kaisha). US Patent 4,054,487. 18 Oct 1977. Priority date 4 Jun 1974, Japan. 4p.

In a nuclear fuel rod, a wound leaf spring member is interposed between a sheath and a stack of fuel pellets contained therein.

12369 New ultrasonic inspection system for non-destructive examination of precision tubes. Pt. 1. A description of the system. Gundtoft, H.E. (Danish Atomic Energy Commission, Risoe. Research Establishment); Agerup, C.V.; Nielsen, T. *NDT Int.;* **10**: No. 4, 171-176(Aug 1977).

From IAEA international seminar on nuclear fuel quality assurance; Oslo, Norway (26 May 1976).

A system based upon a rotating water chamber with eight ultrasonic transducers is described which has been designed for the fast, stringent and automatic inspection of the dimensions of, and defects in, precision tubes such as those used for fuel encapsulation in water-cooled nuclear reactors. The principles incorporated in the system are summarized as follows; both dimension and defect measurements are made using the same system, an ultrasonic pulse-echo technique is used which requires no contacts, measurements of inner diameters are made from the outside of the tube, the spiral scan used is achieved by rotating the transducers instead of rotating the tubes, and results are registered and evaluated by computer. Evaluation and development work on the system that has been carried out, based on practical tube inspection experience, is described.

12370 New ultrasonic inspection system for non-destructive examination of precision tubes. Pt. 2. Computer control. Gundtoft, H.E. (Danish Atomic Energy Commission, Risoe. Research Establishment); Nielsen, N. *NDT Int.;* **10**: No. 4, 177-180(Aug 1977).

From 8. world conference on non-destructive testing; Cannes, France (8 Sep 1976).

In the automatic inspection system of precision tubes, such as those used for fuel encapsulation in water-cooled nuclear reactors, described recently (NDT Internat.; 10:171 (1977)), data (more than half a million per tube) from the ultrasonic dimension measurement and defect inspection are fed into a computer that simultaneously calculates and evaluates the results. This paper describes the development of the computer program used and discusses the advantages of computer control over normal analogue recording techniques. The overall benefits gained by using a computer controlled NDT system are outlined.

12371 Neutron radiographic inspection of nuclear fuels. Ross, A.M. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). *At. Energy Rev.;* **15**: No. 2, 221-247(1977). 154 refs.

Methods for inspecting nuclear fuels by neutron radiography are reviewed briefly, and some facilities around the world for these inspections are described. Some of the qualitative and quantitative information obtained from neutron radiographic inspection of unirradiated fuels is discussed, followed by a review of inspections on irradiated reactor fuels. These are separated into inspections on thermal and fast reactor fuels irradiated under normal reactor conditions, and on those tested under transient (simulated accident) conditions. Lastly, some possible future developments are noted for what is clearly a mature technique for inspecting nuclear fuels nondestructively.

12372 Fuel rod. Hayashi, K.; Sato, K. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1976-149,490/A/. 18 Jun 1975. 4p. (In Japanese).

The object is to provide a member, which will bend when a load in excess of a given limit is exerted thereon, between the lower end plug and the solid fuel pellets to soundly hold fuel rods in the reactor. In a fuel rod with solid fuel material sealed into the fuel clad pipe through upper and lower end plugs, a member, which will bend when a load in excess of set load is exerted thereon, is interposed at least between the end plug and the nuclear fuel material (pellets).

12373 Experimental and analytical study of liquid and two-phase flow induced vibration in reactor fuel bundles. Gorman, D.J. (Univ of Ottawa, Ont). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-52, 1-11(1975).

An instrumented cylindrical tube simulating a reactor fuel pin was subjected to vibration tests in the central position of a seven-element bundle. Tests were conducted with two-phase air-water mixtures and liquid flow. The objective was to establish the effects of mass flow rates and void fractions on the amplitude of vibration. It was found that the amplitude became less dependent on two-phase flow rates as the flow rates were increased. It was also found that for fixed mass flow rates, and void fractions simulating steam qualities greater than 16 percent, no increase in vibration was observed for the range of parameters studied. A simplified analytical formula based on the linear random vibration theory was used to predict response of the pin in two-phase tests. Fairly good agreement was obtained between analysis and experiment. A study was made of the effects which basic parameters have in determining vibration amplitude. 5 refs.

12374 Zircaloy canning tubes--production and mechanical properties. Kallstrom, K. (Sandvik Steel Res Cent, Swed). *Scand. J. Metall.;* **4**: No. 2, 65-74(1975).

With the demands on canning tubes for use in water-cooled thermal nuclear reactors in mind, the production and resulting mechanical properties of Zircaloy tubing are reviewed. Of basic importance is the anisotropy of the hexagonal crystal of the low-temperature modification of zirconium. The crystal anisotropy causes a pronounced texture and a mechanical anisotropy of polycrystalline Zircaloy material. By careful control of how the wall thickness and diameter are reduced during cold rolling in tube production, desired texture and mechanical properties can be achieved. Tensile properties from room temperature up to 400$degree$C are presented as a function of annealing temperature. The effects of the degree of cold work and of texture are shown. Burst properties obtained in open-end and closed-end burst testing are given and the effects of annealing temperature and texture are demonstrated. The mechanical anisotropy of Zircaloy tubing with dominantly radial basal poles in its texture is manifested by its yield locus. Observed strain ratios account for the higher ductility inherent in a texture with radial basal poles which restricts wall thinning. In reactor service the canning tubes should be subjected to a defined straining, implying plane strain condition. This means that the stress ratios will vary with the type of texture, so as to compensate for the inherent higher ductility of tubing with radial basal poles. The difference in creep behavior at 300 and 400$degree$C is emphasized and the effects of creep stress, annealing temperature, cold work, and texture on the 400$degree$C transverse creep properties are reported. Of special importance for the transverse ductility is the hydride orientation. This depends on grain shape, texture and stresses. The effects of annealing temperature and texture on hydride orientation are demonstrated. 13 refs.

12375 Finite element approach to pressure wave attenuation by reactor fuel subassemblies. Belytschko, T.; Kennedy, J.M. (Univ of Ill at Chicago Circle). *Am. Soc. Mech. Eng., [Pap.];* No. 75-PVP-42, 6(1975).

The attenuation of pressure waves by the subassembly walls in a reactor core was studied by a two dimensional, finite element program. For these purposes, a hydrodynamic finite element was incorporated in an existing dynamic structural program. The resulting program has the advantage that complex boundary conditions and the interaction of structural and fluid elements are handled in a straightforward manner. 8 refs.

12376 Heat conduction analysis of composite nuclear fuels. Rust, J.H.; Boyle, D.R. (Ga Inst of Technol, Atlanta). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-30, 8(1975).

A composite fuel for nuclear reactors consists of a fuel matrix containing metal fibers uniformly aligned throughout the matrix. Heat conduction is complicated because heat generation is in the fuel matrix and heat conduction paths are through both the fuel and fibers. Exact analytical solutions were found for temperature distributions in the fibers and matrix in which a composite cell was modeled as concentric circular cylinders. The boundary conditions were insulated outer radial and one axial surfaces and a uniform temperature on the opposite axial surface. A parametric study is presented of composite overall thermal conductivities and temperature distributions as a function of fiber-to-matrix thermal conductivity ratios, cell length-to-radius ratios, and cell-to-fiber radius ratios. 3 refs.

12377 Critical heat flux in a subcooled, low-pressure rod-bundle with various rod spacings. Lund, K.O. (Gen At Co, San Diego, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 75-HT-49, 7(1975).

An experiment was conducted in water at atmospheric pressure using electrically heated rods in a five-by-five square array to simulate nuclear fuel rods. Under highly subcooled conditions, the departure from nucleate boiling (DNB) was found to occur very rapidly in the narrow gaps between the hottest rods. The DNB was too rapid for thermocouple response, so one side of the test section was fitted with a glass wall for visual determination of the DNB. The rod temperatures were measured, and it is shown that the rod temperatures at DNB correspond to published correlations. The critical heat flux was correlated in terms of a critical Stanton number using Reynolds' analogy. By fitting the velocities in the gaps between the rods to the critical heat flux data, it is shown that the critical friction factor used in Reynolds' analogy generally corresponds to other published values. 13 refs.

12378 Cold welding of aluminum for encapsulation of nuclear fuel. Summers, J.R.; Hins, A.G. Dearborn, MI; Society of Manufacturing Engineers (1975). 2p.

Plutonium and U foils for nuclear physics measurements consist of a fuel core sandwiched between two Al (99.45) discs. A leak-tight cladding edge seal is produced by the cold pressure die-welding method.

12379 Device for testing nuclear reactor fuel elements. Bul'kanov, M.G.; Ermilin, N.R.; Zasorin, I.P.; Kurov, V.A.; Slesareva, E.B. USSR Patent 449,379/A/. 5 Nov 1974. 2p. (In Russian). Filed 11 Dec 1970.

The authors suggest a device for thermal sorting of reactor fuel elements during manufacture. The device comprises heating and cooling elements. To approximate experimental-to operating conditions, the fuel element is installed inside a retarder-simulating bushing comprising two concentric bushes with reciprocating motion. Look boxes serve to control the envelope surface with the aid of photometric instruments. An electric range with a cooling system and suitable controls for reproducing thermal conditions are installed in a common rotating housing to allow to inspect the entire surface of the envelope.

12380 Device for investigating mechanical characteristics of tubular samples. Bul'kanov, M.G. USSR Patent 446,117/A/. 5 Oct 1974. Filed date 25 Aug 1972. 3p. (In Russian).

The authors propose a device for investigating the strength properties of tube samples. The device can be employed in the study of the destruction processes occuring in envelopes of fuel elements in nuclear reactors during radiation in the core for subsequent prediction of reactor reliability and efficiency. The device is characterized by an expansion bushing with a gauged longitudinal slot inside the sample examined. The slot is coincided with crack studied, and the clear opening of the slot increases in size along with increase of crack length. This is established by known methods with subsequent recalculation for crack length.

CONTROL SYSTEMS

12381 (AEOI—57) **Representation of PWR control rods in few-group diffusion theory calculations.** Moberg, L.; Solanila, R. (Atomic Energy Organization of Iran, Teheran. Nuclear Research Centre). Sep 1976. 12p. (NRC—76-36). Dep. NTIS (US Sales Only), PC A02/MF A01.

A method is presented for deriving effective diffusion parameters for regions in a PWR core containing control rods. This permits the control rods to be simply and efficiently represented in few-group 2-D diffusion theory reactor calculations.

12382 (EPRI-NP—254) **Study of remote multiplexing for power plant applications.** Kayton, M.; Kinginger, J. (TRW Systems and Energy Group, Redondo Beach, Calif. (USA)). Sep 1977. 42p. Dep. NTIS, PC A03/MF A01.

The Executive Summary to a three volume report on Remote Multiplexing Systems (RMS) for power plant applications is presented. Increasingly, these systems are being considered by utilities as an alternative to conventional hardwiring for the transmissions of data and control signals to and from the thousands of devices in a power plant. The reports indicate that remote multiplexing is technically feasible, can be designed to meet availability requirements, may save millions of dollars as a hardwire replacer, and will provide other significant advantages. However, there are many application dependent parameters; and therefore, a general methodology is documented so that installation specific analyses can be performed. Because plant productivity could be impacted by unsatisfactory RMS performance, the utilities may wish to give special attention to the many technical considerations reviewed in the reports as this new technology is introduced. The technical findings summarized include: (1) detailed RMS functional requirements; (2) analysis of representative non-safety and safety RMSs configured for the reference plant; (3) comparison of capability and cost of different RMSs and conventional hardwiring; (4) analysis of RMS availability and its impact on plant operations translated to present value; and (5) discussions of significant technical design areas.

12383 (EPRI-NP—254-SY) **Study of remote multiplexing for power plant application.** Kayton, M.; Kinginger, J. (TRW Systems and Energy Group, Redondo Beach, Calif. (USA)). Sep 1977. 42p. Dep. NTIS, PC A03/MF A01.

An Executive Summary to a three volume report on Remote Multiplexing Systems (RMS) for power plant applications is presented. Increasingly, these systems are being considered by utilities as an alternative to conventional hardwiring for the transmissions of data and control signals to and from the thousands of devices in a power plant. The reports indicate that remote multiplexing is technically feasible, can be designed to meet availability requirements, may save millions of dollars as a hardwire replacer, and will provide other significant advantages. However, there are many application dependent parameters; and therefore, a general methodology is documented so that installation specific analyses can be performed. Because plant productivity could be impacted by unsatisfactory RMS performance, the utilities may wish to give special attention to the many technical considerations reviewed in the reports as this new technology is introduced.

12384 (Juel—1371) **PROREX data acquisition and control of reactor experiments with a process computer.** Bachner, E.; Kloeckner, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Zentralabteilung Allgemeine Technologie). Dec 1976. 21p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

A Siemens 301 process computer is used for reactor experiments on the FRJ-2. The tasks which this computer is to carry out are, above all, the acquisition of measured values and their processing, control of experiments and, to a small extent, reactor control. The publication at hand describes the tasks put to the computer and their realization by means of the software.

12385 (MRR—160) **Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.** (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Reaktordynamik und Reaktorsicherheit). Jul 1976. vp. (AED-Conf—76-348-006; CONF-760575—). NTIS.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

Each paper presented at the meeting has been separately processed for the data base. (HDR)

12386 (MRR—160, pp 151-174) **Model building, identification and control of a BWR nuclear power plant.** Beraha, D. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 2: direct digital plant and core control.

Some developments towards digital control of a BWR nuclear power plant based on optimal control theory are presented. The steps considered include the building of a suitable nonlinear model, identification of its parameters and control in the vicinity of the operating point employing the linearized model. Since the performance of the whole control system will, to a high degree, depend on the model quality, considerable effort has been and will further be spent in modelling to reach an efficient description of the main dynamic processes in a BWR plant.

12387 (MRR—160, pp 393-401) **Studies of low level analog data aquisition systems of computers used in PWR nuclear power plants.** Champiot, G.; Varaldi, G. (Electricite de France, 75 - Paris). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 4: computer configurations for on-line functions.

This report deals with the following points: (1) review of the facilities, testing Electricite de France for testing low level analog data acquisition systems; (2) description of connecting line tests for electrical noise immunity; (3) compatibility of loads connected in parallel on a measurement line; and (4) laboratory testing methodology applied to data acquisition systems.

12388 (MRR—160, pp 241-262) **Computer functions in overall plant control of Candu generating stations.** Chou, Q.B.; Stokes, H.W. (Ontario Hydro, Toronto (Canada)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 3: experience with digital control in plant operation and commissioning.

System Planning Specifications form the basic requirements for the performance of the plant including its response to abnormal situations. The rules for the computer control programs are devised from these, taking into account limitations imposed by the reactor, heat transport and turbine-generator systems. The paper outlines these specifications and the limitations imposed by the major items of plant equipment. It describes the functions of each of the main programs, their interactions and the control modes used in the existing Ontario Hydro's nuclear station or proposed for future stations. Some simulation results showing the performance of the overall unit control system and plans for future studies are discussed.

12389 (MRR—160, pp 117-127) **Plant disturbance analysis by process computer. On-line operation and operator communication.** Dahll, G.; Grumbach, R.; Netland, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

A system for on-line analysis of plant disturbances is described with special emphasis on the performance of the system with respect to its operator communication features. On the basis of a-priori analyses of plant disturbances and the current acquisition of process data, the system carries out an on-line analysis of disturbance situations and presents the result on a colour TV-screen. Upon the occurrence of an alarm, the analysis system will assist the operator in finding the causes of the disturbances and its possible consequences, and inform him about the proper actions to be taken. During the analysis, the system will need information on the plant status. This can be achieved, either by direct reading and analysis of process data, or by answers from the operator to questions presented by the system. By interacting with the analysis programme, the operator may to a large extent select the amount of details in the information on the disturbance. The results may be presented to the operator in a form combining texts and diagrams to ease the operators' understanding of the analysis. This paper discusses alternative approaches to the form of presentation.

12390 (MRR—160, pp 177-186) **Simulation study of an integrated plant control concept for a BWR.** Espefaelt, R.; Fagerstroem, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 2: direct digital plant and core control.

A computer control concept for integrated control of pressure and generator power output in a BWR plant has been tested by simulations using the STUDS-1 non-linear simulation model on the hybrid computer system in Studsvik. The control concept is similar to one that has been developed at the Halden Project and is based on the linear quadratic approach of optimal control theory.

12391 (MRR—160, pp 311-320) **System architecture for microprocessor based protection system.** Gallagher, J.M. Jr.; Lilly, G.M. (Westinghouse Electric Corp., East Pittsburgh, Pa. (USA)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 4: computer configurations for on-line functions.

The architectural design features to be employed by Westinghouse in the application of distributed digital processing techniques to the protection system are discussed. While specific reference is made to microprocessors, this is only one (and the newest) of the building blocks which constitutes a distributed digital processing system. The actual system structure (as realized through utilization of the various building blocks) is established through considerations of reliability, licensability, and cost. These considerations are examined as they relate to the architectural design features.

12392 (MRR—160, pp 511-529) **Computers processing the temperature in the core of Phenix.** Grisollet, J.; Quenee, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Jul 1976. (In French).

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: computers in plant protection.

The operational reliability of industrial mini-computers justifies their application in reactor protection systems. Taking into consideration the conclusions drawn from experience, improvements have been made on the installation for monitoring core temperatures (TRCT) at the Phenix reactor resulting in the fact that during the last six months of operation no failures have been detected.

12393 (MRR—160, pp 103-113) **Plant disturbance analysis by process computer. Basic development and experimental tests.** Grumbach, R.; Hoermann, H. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Reaktordynamik und Reaktorsicherheit). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

Disturbance analysis is presented as an integrated procedure comprising both preparatory off-line evaluations of the plant to be supervised and computerized analyses of the current plant status. This paper outlines the stages of development towards an on-line disturbance analysis system and shortly describes the functions of the input generating programme MOGEN and the on-line analysis routine ALSAN which have been produced so far. The performance of the ALSAN routine is discussed on the basis of test results obtained during experiments with the Halden Reactor Plant; in these experiments, the disturbances to be analyzed by ALSAN were introduced by intentional mal-operation of plant components.

12394 (MRR—160, pp 205-215) **Computerized strategy for controlling xenon oscillations.** Hanke, W. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 2: direct digital plant and core control.

The optimal control of spatial xenon oscillations is formulated as a minimal time control problem. This leads to a BANG-BANG-type control. A method to minimize the performance index is given. Correlations between the switching times and the time behaviour of the free oscillation lead to a simple rule for the control rod movement. The correlation is derived by numerical experiments with a reactor code simulating a slab reactor with HTR-data. It is shown, that the development strategy damps xenon oscillations very efficiently.

12395 (MRR—160, pp 265-288) **Experience in the operation and maintenance of digital computer systems of a nuclear power plant.** Hashmi, J.; Iqleem, J.; Jafri, M.N.; Siddiqui, Z.H. (Pakistan Atomic Energy Commission, Karachi). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 3: experience with digital control in plant operation and comissioning.

The Karachi Nuclear Power Plant (KANUPP) employs a dual-digital computer control system for on-line plant control and for fuel handling control. Experience with operation and maintenance of these digital computer systems has shown the need for a third computer for each of the systems. These third computer systems are housed in the KANUPP Computer Centre and are used for training, as a source of tested spares, dynamic test facility for the repair of defective cards and for program reassembly. An analog computer system and mock-up of the plant control consoles have been interfaced with one of the digital computer systems to provide a facility for dynamic testing of control programs under simulated plant conditions.

12396 (MRR—160, pp 321-346) **Micro/mini computer network for applications in nuclear station instrumentation and control.** Hassan, M.K.; Ibrahim, M.A.; Madkour, M.A.; Ghonaimy, M.A.R. (Atomic Energy Establishment, Cairo (Egypt)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 4: computer configurations for on-line functions.

Different types of computers now available open new avenues for implementing hierarchical instrumentation, control and management systems. Each control level may be implemented by more than one computer level to increase the reliability and flexibility of the system and reduce software complexity.

12397 (MRR—160, pp 531-543) **Computers in the core supervision and protection system at Creys Malville (Super Phenix).** Jeannot, A.; Grisollet, J.; Gourdon, J.; Paziaud, A. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France)). Jul 1976. (In French).

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: computers in plant protection.

In French nuclear power plants there is a tendency to distinguish between conventional handling of information by a computer (monitoring of a measurement with respect to a threshold, contact monitoring) and management of the process according to each

reactor type. In case of the Super Phenix the process management has been voluntarily subdivided by specialized tasks in order to increase the availability and in order to facilitate the intervention into the logic part during start-up and operation. The interconnection of 5 computers lead to numerous precautions to avoid that they might disturb each other and to meet the current regulations.

12398 (MRR—160, pp 437-448) **Determination and use of sensor status information in computer based monitoring and protection systems.** Johnstone, W.; Pooley, D. (UKAEA Health and Safety Branch, Harwell). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: Computers in plant protection.

One of the potential advantages of using computers to process the data from plant instrumentation is that the computer can, via a test routine interleaved with the main routines, thoroughly check the sensors and the associated telemetry system at frequent intervals. In nuclear plants the sensors are often in a fairly difficult environment where failures which may hazard the smooth operation of the plant can indeed occur, and in this situation a frequent yet searching test of the sensor and telemetry can be particularly useful.

12399 (MRR—160, pp 219-232) **Two optimal control methods for PWR core control.** Karppinen, J.; Blomsnes, B.; Versluis, R.M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 2: direct digital plant and core control.

The Multistage Mathematical Programming (MMP) and State Variable Feedback (SVF) methods for PWR core control are presented in this paper. The MMP method is primarily intended for optimization of the core behaviour with respect to xenon induced power distribution effects in load cycle operation. The SVF method is most suited for xenon oscillation damping in situations where the core load is unpredictable or expected to stay constant. Results from simulation studies in which the two methods have been applied for control of simple PWR core models are presented.

12400 (MRR—160, pp 465-477) **Fail-safe computer-based reactor protection system.** Keats, A.B. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: computers in plant protection.

It is possible to bestow fail-safe properties upon any data handling system by specifying that the output shall be dynamic (i.e. shall cyclically alternate between two or more static states) and that all internal states shall also be dynamic. The choice of cyclic sequence of static states must ensure that every part of the system (each bit) is regularly exercised at a rate determined by the maximum MTTR (mean time to repair) of the system which in turn must be short compared with the MTBF (mean time between failures). Although the examples given are of very simple computer tasks which basically replace conventional trip unit and safety circuit logic hardware, the principles could be extrapolated to more complex data processing tasks.

12401 (MRR—160, pp 347-358) **Study of failure-survival closed-loop plant autocontrol systems employing redundant microprocessors.** Lawrence, L.A.J.; Page, N.; Wells, F. (British Aircraft Corp. (Operating) Ltd., Bristol). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 4: computer configurations for on-line functions.

Failure-survival techniques already in use in the nuclear industry can be further enhanced by the application of up-to-date developments in the avionics field. It is concluded that provided appropriate facilities are provided for failure detection, on-line replacement of failed units, periodic and automatic complete system checks, and deselection of failed units, it should be possible to obtain a system failure rate in the range 10^{-5} to 10^{-6} per hour using a triplex control system, depending on the quality of the components, the on-line repair time and the interval between (automated) system check-out.

12402 (MRR—160, pp 449-463) **Micro processors for plant protection.** McAffer, N.T.C. (UKAEA Reactor Group, Risley). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: computers in plant protection.

Micro computers can be used satisfactorily in general protection duties with economic advantages over hardwired systems. The reliability of such protection functions can be enhanced by keeping the task performed by each protection micro processor simple and by avoiding such a task being dependent on others in any substantial way. This implies that vital work done for any task is kept within it and that any communications from it to outside or to it from outside are restricted to those for controlling data transfer. Also that the amount of this data should be the minimum consistent with satisfactory task execution. Technology is changing rapidly and devices may become obsolete and be supplanted by new ones before their theoretical reliability can be confirmed or otherwise by field service. This emphasises the need for users to pool device performance data so that effective reliability judgements can be made within the lifetime of the devices.

12403 (MRR—160, pp 361-370) **Computerized supervision and control concept for nuclear power plants based on experience obtained from operation of the Halden reactor.** Netland, K.; Oevreeide, M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 4: computer configurations for on-line functions.

Based on several years of research and development in the field of supervision and control of nuclear power plants, and on experience from operation of the Halden Reactor, a supervision and control concept, meeting the requirements to high hardware and software reliability and system availability, has been devised. This new concept will also enable fast response on operator's requests and control actions, proper updating of process information on the displays, simultaneous supervision and control of different plant circuits, etc. The present low cost generation of computers has the potential for removing previous technical and economical constraints and enable a decentralization of functions. Configurations meeting the hardware requirements to redundancy and physical separation can be obtained, which at the same time offer possibilities for reduction of software complexity. The separation of functions will furthermore increase the processing capacity. Software organization has remained one major obstacle to successful application of multiprocessor systems, since software organization so far primarily has been oriented towards single processing configurations. As far as increased reliability through modularity is concerned, the subjects of hardware and software reliability must be sufficiently integrated to achieve a high total system reliability. In view of such demands, this paper discusses alternative approaches to the technical realization of the above mentioned concept.

12404 (MRR—160, pp 289-299) **Computer aided (pre-) commissioning of the reactor control systems.** Simon, A. (Allmaenna Svenska Elektriska AB (ASEA), Vaesteraas). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 3: Experience with digital control in plant operation and commissioning.

The paper describes experiences of Asea-Atom with reactor control systems design based on simulations using computer codes for the process and for the controller to be manufactured.

12405 (MRR—160, pp 189-201) **Some results in the design of a hierarchical control system.** Zobor, E. (Kozponti Fizikai Kutato Intezet (Hungary)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 2: direct digital plant and core control.

Taking the WWR-SM reactor as a guiding example, a hierarchical control system is being investigated in the framework of the IAEA Research Contract 'Computer Control System Synthesis for Nuclear Power Plants through Simplification and Partitioning of the Complex System Model into a Set of Simple Sub-systems' (No. 1194/RB and 1194/R1/RB). After a short description of the control

system concept, in the paper the results referring to the system partitioning into sub-systems, to the coordination and to the identification of the one-point model parameters are briefly discussed.

12406 (MRR—160, pp 1-17) **Supervision and diagnosis of the operation of nuclear reactors by real-time identification techniques.** Zwingelstein, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service d'Electronique). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

The object of this communication is to describe supervision and diagnosis techniques which may also be used for transients. These methods are principally based on real-time identification techniques implanted in industrial computers. Several illustrations of these methods using signals received by different reactors prove the efficiency of these supervision and diagnosis methods.

12407 (MRR—160, pp 301-305) **Chairman's report: Experience with Digital Control in Plant Operation and Commissioning.** Zwingelstein, G.; Schueller, H. Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 3: experience with digital control in plant operation and commissioning.

The present paper summarizes the results of contributions to the session III of the IAEA/NPPCI Specialists' meeting on use of computers for protection systems and automatic control held in May 76 in Neuherberg/Munich.

12408 Automatic motion inhibit system for a nuclear power generating system. Torres, J.M. (to Combustion Engineering, Inc.). US Patent 4,055,463. 25 Oct 1977. Filed date 18 Aug 1975. 18p.

Disclosed is an automatic motion inhibit system for a nuclear power generating system for inhibiting automatic motion of the control elements to change the reactor power in response to turbine load changes. A final reactor power level setpoint is continuously compared with reactor power and a setpoint-greater-than-power signal is generated when the final reactor power level setpoint is greater than the reactor power. The final reactor power level setpoint is a setpoint within the capacity of a steam relief valve system which in no event is lower in value than the lower limit of automatic operation of the automatic motion control means. Also the reactor power demand or turbine load is continuously compared with a predetermined power demand threshold and a demand-less-than-threshold signal is generated when the reactor power demand is less than demand threshold. Then if both the setpoint-greater-than-power and demand-less-than-threshold signals are present an inhibit signal is generated which inhibits the automatic motion control means from responding to turbine load changes. Also an automatic lock-in system is disclosed for preventing premature termination of the inhibit signal as the turbine load is increased above the predetermined demand threshold.

12409 Nuclear reactor fail-safe unit having the function of control relay and current regulation. Lefebvre, C.; Therond, J.P. (to Commissariat a l'Energie Atomique). US Patent 4,054,486. 18 Oct 1977. Priority date 11 Dec 1974, France. 18p.

An electronic unit for controlling the safety absorbers of a nuclear reactor comprises a self-supplied AND_1 circuit for performing logical multiplication of input signals each capable of assuming one out of two values, series-connected modules each constituted by a dc/ac converter, the output of the last module being coupled to the first converter and to a regulator input at which is obtained a logical a.c. signal whose value corresponds to the result of multiplication of the different input signals, a static intensity regulator with negative current feedback for modulating the width of the square waves delivered by an isolation transformer, a rectifier for delivering a constant current to a load impedance.

12410 Simplified frequency-response design approach for power-station control. Hughes, F.M. (Univ of Manchester Inst of Sci and Technol). *Int. J. Control;* **25**: No. 4, 575-587(Apr 1977).

The paper outlines a modified multivariable frequency-response approach to design which takes advantage of the particular characteristics and control requirements of a nuclear power-station. The usual design aim of achieving low interaction levels following disturbances in any loop is relaxed to one where low interaction is required following a disturbance in only one loop, leading to improved power-response performance by means of a simpler controller and design procedure. 9 refs.

12411 Control of the locus-dependent neutron density in a nuclear reactor. Stark, K. (Univ Stuttgart, Ger). *Regelungstechnik;* **23**: No. 7, 217-223(Jul 1975). (In German).

The control scheme developed is based on a nonlinear axial model of the reactor. The controlled variable is the axial distribution of the neutron density; control variables are the positions of several control rods. The control scheme is designed to control the eigenfunctions of the neutron density. It is independent of the operating power level of the reactor. 9 refs.

12412 Method for installing a control rod driving device in a reactor. Sato, H.; Watanabe, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-105,596/A/. 19 Feb 1975. 4p. (In Japanese).

The object is to install a device using a wire rope, including individually moving up and down a control rod and a control rod driving device thereby enabling installation in a low house and to reduce time required for installation. The control rod is temporarily attached to a support structure for the control rod driving device, the control rod driving device is suspended on a crane positioned upwardly of the support structure, a rope connected to the control rod driving device is connected to the control rod, a sagged portion of the rope is then wound about a rotary cylinder, the control rod is disconnected from its temporary attachment, and the wound rope is wound back while the rotary cylinder is rotated to move down the control rod. After the rope has been released from the rotary cylinder, the control rod driving device is moved down by the crane.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 13069

12413 (ORNL/TM—5927) **Expansion potential for existing nuclear power station sites.** Cope, D.F.; Bauman, H.F. (Oak Ridge National Lab., Tenn. (USA)). 26 Sep 1977. Contract W-7405-ENG-26. 146p. Dep. NTIS, PC A08/MF A01.

This report is a preliminary analysis of the expansion potential of the existing nuclear power sites, in particular their potential for development into nuclear energy centers (NECs) of 10 (GW(e) or greater. The analysis is based primarily on matching the most important physical characteristics of a site against the dominating site criteria. Sites reviewed consist mainly of those in the 1974 through 1976 ERDA Nuclear Power Stations listings without regard to the present status of reactor construction plans. Also a small number of potential NEC sites that are not associated with existing power stations were reviewed. Each site was categorized in terms of its potential as: a dispersed site of 5 GW(e) or less; a mini-NEC of 5 to 10 GW(e); NECs of 10 to 20 GW(e); and large NECs of more than 20 GW(e). The sites were categorized on their ultimate potential without regard to political considerations that might restrain their development. The analysis indicates that nearly 40 percent of existing sites have potential for expansion to nuclear energy centers.

SITING

REFER ALSO TO CITATION(S) 12273, 13083

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 13070, 13072

12414 (STH—13/76) **Studies on the emission of ^{14}C with the waste air from nuclear power stations.** Riedel, H.; Gesewsky, P.; Schwibach, J. (Bundesgesundheitsamt, Neuherberg/Muenchen (Germany, F.R.). Inst. fuer Strahlenhygiene). Dec 1976. 45p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In this paper data on the emission of C-14 in the airborne effluent from nuclear power plants are reported. First of all, an overview of previously published results in the United States is given. Then the methods of sampling and measurement used here and the results of measurements at the nuclear power plants Gundremmingen, Lingen, Obrigheim, Wuergassen, Stade and Biblis Block A are described. Both, the data from the previous publications as well as from the measurements reported here confirm an emission of about 10 Ci C-14/GWsub(e)a, which had been calculated on the basis of nuclear and technical data before. The individual values of activity concentration of C-14 in samples of off-gas or airborne effluents lie in general in a range that corresponds to a calculated emission of 1 to 20 Ci C-14/GWsub(e)a. The fraction of C-14 in the form of carbon dioxide was found to be 95% at BWR's and about 40% at PWR's. The rest of the C-14 is released in the chemical forms of carbon monoxide, methane and other hydrocarbons. The measurements will have to be continued, to get more precise statements on the average emission during a whole year of operation of the nuclear power plants investigated.

12415 Monitoring of emissions and immissions from nuclear power plants. Schroeder, H.J. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Biblis (Germany, F.R.). Betriebsverwaltung). *VGB Kraftwerkstech.;* **57**: No. 2, 106-111(Feb 1977). (In German).

The measurement of the emission and immission of radionuclides from nuclear power stations has already been established with the inception of the peaceful uses of atomic energy. Since then it has been a firm feature of the monitoring of effects of nuclear power plants on the environment. The considerations and procedures on which the measurement programs are based are described. The ecological behaviour of radionuclides is illustrated with the aid of examples.

12416 Control, monitoring, and reporting of radioactivity in effluents. I and II. Biles, M.B.; Coffman, F.E. (US AEC, Washington, DC). *Nucl. Saf.;* **16**: No. 1, 60-75(Jan-Feb 1975).

Programs for monitoring and reporting of radioactivity in effluents are maintained at all U.S. Atomic Energy Commission (AEC) facilities discharging concentrations of radioactivity that have potential health and safety or environmental significance. To ensure the effective management and control of effluents is the objective of these programs. To maintain an overview of its effluent-control practices, the AEC has developed and instituted a computer-based annual effluent-data reporting system to ensure that effluent-control programs are properly maintained. Part 2 reports limitations and requirements for control and monitoring of radioactive effluents expressed in AEC regulations issued under Title 10, Code of Federal Regulations. AEC regulations and policies for control of exposures from radiation and radioactive materials are based primarily on guidance promulgated by the International Commission on Radiation Protection, the National Council on Radiation Protection, and the Federal Radiation Council. 4 refs.

CHEMICAL AND THERMAL EFFLUENTS

12417 (Juel-Conf—23, pp 138-145) **Use of thermal wastes from nuclear power plants.** Balligand, P. Dec 1976.

From Symposium on nuclear energy applications other than electricity production; Julich, F.R. Germany (29 Apr 1976).

In Nuclear energy applications other than electricity production. Session B: nuclear district heating and low temperature applications.

A glance at the diagrams which summarize national primary energy consumption expressed in tons of oil equivalent for various needs shows that 50% and sometimes more of the energy imput is lost during use. It is only logical that an attempt is being made to use this lost energy. However the solution is not an easy one, as it generally involves energy which is widely distributed in low temperature wastes, at any event in the case of present-day electrical power plants, and the economics of the project must be carefully examined. In the case of agriculture, it may be asserted that many solutions for recovery are available depending on the type of waste. These uses are likely to reduce the fuel consumption of agricultural farms and the areas which can be heated are considerable. However, this means concentrating agricultural installations likely to benefit from hot water economic problems. As for urban heating with a heat pump, in order for the system to be economical, we feel that water must be available at least at the temperature of the water from cooling towers, a minimum of 30°C, together with a high user density in the immediate vicinity of the power plant.

12418 Dissipation of heat from artificially heated stretches of running water. Glaser, H. (Univ Stuttgart, Ger). *Chem.-Ing.-Tech.;* **49**: No. 5, 381-391(May 1977). (In German with English abstract).

It has been common practice to feed waste heat from nuclear reactors into nearby rivers, where marked increases in temperature have been recorded. Various ways for calculating the amount of heat dissipated in flowing waters have been proposed. Satisfactory results are obtained if the amounts of heat transferred by convection, evaporation, and radiation are determined separately, since the prevailing meteorological and hydrological conditions can then be readily taken into consideration. Decisive correlations can be readily determined and illustrated diagramatically. 9 refs.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 12241

12419 (ECN—19) **Time-of-flight measurements in STEK.** Oei, T.D.; Dekker, J.W.M.; Quaadvliet, W.H.J. (Stichting Energieonderzoek Centrum Nederland, Petten). Mar 1977. 64p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Time-of-flight measurements have been performed in the STEK facility to measure the neutron spectra of the different cores. The measured spectra of the subcritical fast cores have been converted into the spectra of the critical fast-thermal coupled cores with computed conversion factors. Systematic errors due to anisotropy effects of the core and the cell heterogeneity were investigated. Time-dependent and static diffusion calculations were performed to account for the influence of the spectrum time dependence. The neutron time-of-flight distribution is converted into the neutron energy spectrum by an unfolding method which requires a priori knowledge of the spectrum.

12420 (IEA—422) **Calculation of the fissile mass of a graphite moderated critical assembly using 93% enriched uranium.** Correa, F.; Marzo, M.A.S.; Collussi, I.; Ferreira, A.C.A. (Instituto de Energia Atomica, Sao Paulo (Brazil). Divisao de Engenharia Nuclear). Jun 1976. 26p. (In Portuguese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The critical mass of uranium has been calculated for a graphite moderated set fueled with 93% enriched uranium to be mounted on the Instituto de Energia Atomica split table Zero Power Reactor. The core composition was optimized to permit the maximum number of configurations to be studied. Analysis of three core compositions shows that 8 Kg of uranium enriched to 93% - U-235 (by weight) and 100 Kg of thorium would be sufficient for criticality experiments.

12421 (JINR-R—3-7946) **CM-2 high-flux reactor as an effective source of ultracold neutrons.** Zamyatin, Yu.S.; Kolesov, A.G.; Kulagin, E.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1974. 13p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A device for production of UCN in a horizontal channel of the high-flux reactor CM-2 is described. Taking into account the effficiency of the used detection method there was estimated the extracted flux of UCN which is the maximum one obtained at present (approximately 10^3 sec^{-1}). Witthin 15 days of continuous operation of the reactor there was not observed a noticeable decay in the UCN yield. A conclusion is drawn about the possible use of the reactor CM-2 as an effective source of UCN.

12422 (Juel—1368) **Reactivity measurements at the graphite-moderated critical facility KAHTER by means of neutron noise analysis.** Suessmann, H.F.; Brixy, H.; Hecker, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Dec 1976. 53p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Measurements of reactivity and the prompt decay constant were performed in an extremely slow system (asub(C) = 3.8 s^{-1}) - the critical facility KAHTER - using a new measuring method on the basis of neutron noise analysis. This method gives information about the state of the reactor in a short time and with relatively little instrumentation compared with other methods. A calculational correction of the measuring results is not necessary as they are independent from the position of the detectors at a given reactor state. The subcriticality is evaluated from the zero crossing point of the correlation function. The lowest possible detector efficiency was determined in order to get information on the applicability of the method with power reactors. The result was that the use at large HTR-reactors to control the subcritical state during shut down periods might be difficult, because in such cases it seems to be almost impossible to realize the needed detector efficiency of about 10^{-4}. The method is applicable however for asub(C)-measurements even in large HTR-reactors during the first start up of the reactor.

12423 (KFK—2385) **Computation, measurement and analysis of the reactivity-to-power-transfer-function for the sodium cooled nuclear power plant KNK I.** Hoppe, P.; Mitzel, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Feb 1977. 86p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The Reactivity-to-Power-Transfer-Function for the sodium cooled nuclear power plant KNK I (Kompakte Natriumgekuehlte Kernenergieanlage) has been measured and compared with theoretical results. The measurements have been performed with the help of pseudostochastic reactivity perturbations. The transfer function has been determined by computing the auto- and cross-power-spectral-densities for the reactivity- and neutron flux signals. The agreement between the experimental and theoretical transfer function could be improved by adjusting the reactivity coefficients. The applications of these measurements with respect to reactor diagnosis and malfunction detection are discussed. For this purpose the accuracy of the measured transfer function is of great importance. Therefore an extensive error analysis has been performed. It turned out, that the inherent instability of the reactor without control system and the feedback by the primary coolant system were the reasons for comparatively big systematical errors. The conditions have been derived under which these types of errors can be considerably reduced. The conclusions can also be applied to analogical measurements at fast sodium cooled reactors. Because of their inherent stability the systematical errors will be reduced.

12424 (ORNL/TM—6127) **Bulk Shielding Facility quarterly report, April, May, and June of 1977.** Hurt, S.S. III; Lance, E.D.; Thomas, J.R. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

The BSR operated at an average power level of 1,821 kW for 39.82 percent of the time during April, May, and June. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. The BSR was operated at low and variable power during this quarter for 91.517 hours as part of the training programs for nuclear reactor operator trainees from Memphis State University and nuclear engineering students from the University of Tennessee. The PCA was also used in the above-mentioned training programs and was operated on twelve occasions when Central Florida Community College, the University of Kentucky, and Memphis State University students actively participated in training laboratories.

12425 (TREE-NUREG—1109) **Principles of operation and data reduction techniques for the loft drag disc turbine transducer.** Silverman, S. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1977. Contract EY-76-C-07-1570. 157p. Dep. NTIS, PC A08/MF A01.

An analysis of the single- and two-phase flow data applicable to the loss-of-fluid test (LOFT) is presented for the LOFT drag turbine transducer. Analytical models which were employed to correlate the experimental data are presented.

12426 (UCRL—52000-77-6, pp 1-8) **Livermore pool-type reactor.** Mann, L.G. Jun 1977.

In Energy and technology review.

The Livermore Pool-Type Reactor (LPTR) has served a dual purpose since 1958—as an instrument for fundamental research and as a tool for measurement and calibration. Our early efforts centered on neutron-diffraction, fission, and capture gamma-ray studies. During the 1960's it was used for extensive calibration work associated with radiochemical and physical measurements on nuclear-explosive tests. Since 1970 the principal applications have been for trace-element measurements and radiation-damage studies. Today's research program is dominated by radiochemical studies of the shorter-lived fission products and by research on the mechanisms of radiation damage. Trace-element measurement for the National Uranium Resource Evaluation (NURE) program is the major measurement application today.

12427 (ZfK—325) **Determination of dynamic parameters of the reactor Bor-60 by means of a reactivity modulator.** Krause, H.; Otto, H.; Scholz, J.; Ziegenbein, D.; Afanasjew, W.; Britov, W.; Grjasew, W.; Jefimow, W.; Kebadse, B. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Feb 1977. 20p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

It is reported about first transfer function measurements performed at the reactor BOR-60 in the range 0.05 to 18 cps and at powers up to 45 MW by means of a rotating reactivity modulator. The construction of the modulator is described roughly. Its reliability is treated. By fitting the results of the measurements to a simple model for the heat transfer in the reactor it could be shown, that the dynamics of the reactor for frequencies >0.05 cps may be described by one power coefficient with the adequate time constant.

12428 Performance of highly rated UO_2 fuel in the WR-1 organic-cooled reactor. Schankula, M.H.; Hastings, I.J. Chalk River, Ont.; Atomic Energy of Canada, Ltd. (Jul 1977). 43p.

To provide data on the release of fission gases from fuel operating at high fuel surface temperatures and low external restraint, which are required as part of the organic-cooled power reactor (OCR) study, UO_2 fuel with cold-worked Zr-2.5 wt% Nb sheathing was irradiated in the WR-1 organic-cooled reactor to burnups of 135-154 MWh/kgU at a time-averaged linear power of 60-63 kW/m. Elements with 0.38 and 0.69 mm thick sheathing showed maximum diametral increases averaging 3.7 and 1.7% respectively at pellet mid-planes. Reduced fuel/sheath heat transfer resulting from a difference between internal gas pressure and coolant pressure produced high operating temperatures, and there was evidence of central melting in some elements. Fission gas releases were 30-60%. In the heat-affected zone adjacent to brazed appendages, the diametral increases were lower, averaging 0.9 and 0.5% for 0.38 and 0.69 mm thick sheathing respectively. Heat treatment during the brazing process produced a local improvement in sheath creep strength. 24 refs.

12429 Profiles of activity ratios of fission products, cesium-134, cesium-137 and ruthenium-106 in low-enriched PuO_2-UO_2 fuel assemblies. Tsuuta, H.; Suzaki, T.; Matsuura, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 1, 43-53(Jan 1977).

Distributions of fission products of low-enriched PuO_2-UO_2 fuel assemblies irradiated in a D_2O-moderated power reactor were non-destructively measured by γ-ray spectrometry with a Ge(Li) detector. Proportionality was observed between the ^{134}Cs to ^{137}Cs activity ratio and the activity of ^{137}Cs, which was a measure of the burnup of a fuel element. The proportionality constant depends on the specifications of the fuel element, such as size, density and enrichment as well as on the irradiation history. The burnup ratio between two fuel assemblies could be determined from the values of the activity ratio between ^{134}Cs and ^{137}Cs or from the activity of ^{137}Cs. The results proved to be in fair agreement with the indications obtained from reactor instrumentation. The distributions of the ^{106}Ru to ^{137}Cs activity ratio were almost flat, both along the axis and across the fuel assembly. This flat distribution is a distinctive characteristic of irradiated PuO_2-UO_2 fuel rods and could be utilized as an indication of whether or not Pu was originally contained in a fresh fuel rod.

12430 Detection of cracks in TRIGA fuel rods by neutron radiography. Pochmann, W.A.; Zeilinger, A.; Boeck, H. (Atominstitut der Oesterreichischen Hochschulen, Vienna). *Atomkernenergie;* **29**: No. 3, 231(1977).

12431 Fuel rod bowing resulting from internal pellet motion. Lussie, W.G.; Wadkins, R.P. (EGandG Idaho, Inc, Idaho Falls). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-29, 1-8(1977).

This paper discusses the power fluctuation arising from fuel bowing that occurred in the Power Burst Facility (PBF). PBF is a nuclear safety research reactor located at the Idaho National Engineering Laboratory. Two mechanisms that were investigated, namely, hydraulic conditions in the fuel canisters and pellet movement in the fuel rods. Both mechanisms could result in fuel rod bowing; however, the latter was established as the source of the power fluctuations and the mechanism is a peculiar characteristic of the PBF fuel rod design. 9 refs.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

12432 (AERE-M—2883) **Measurement of PLUTO transfer function at 23 Mw.** Kenward, C.J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Mar 1977. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Measurements of the PLUTO reactor transfer function have been made to determine the usefulness of the method as an aid to absorber calibration and reactor safety generally. A low reactor powers the method is quite feasible and could be used in place of existing techniques, having the advantage of being insensitive to drifting temperatures etc. It could be used to give advance warning of criticality even when the reactor flux was changing rapidly due to fission product decay following shutdown. At full reactor power the transfer function is seriously affected by delayed thermal feedback in the heavy water coolant. It may still be possible to use the method to calibrate the main absorbers providing a frequency of at least 1.3 Hz can be used, but is is recognised that an oscillator with the necessary speed of response poses considerable engineering difficulties. At the end of each reactor cycle a reactivity calibration over the working range of the control absorbers would be produced to gain information on the variability of the system. This tentative conclusion is based on an extrapolation of present work, further measurements at higher frequencies are required to properly judge the feasibility of this proposal.

12433 Analysis of an in-pile reactor tube. von Riesemann, W.A.; Gubbels, M.H. (Sandia Lab, Albuquerque, NM). *Am. Soc. Mech. Eng., [Pap.];* No. 75-DET-43, 1-8(1975).

The paper presents the results of an analysis of an in-pile pressure tube and its components which are subjected to a severe dynamic overpressure pulse. The in-pile tube is part of a closed loop used in the Power Burst Facility at the Idaho National Engineering Laboratory. This facility is used to test power reactor fuels. The paper describes the hardware, loading conditions and modeling techniques. A two-dimensional dynamic nonlinear finite element computer program HONDO was used in the analysis. 8 refs.

PROPULSION REACTORS

12434 (GKSS—77/E/2) **Experiences during the exchange of fuel elements of the NS OTTO HAHN.** Scharge, J.; Manthey, H.J.; Schafstall, H.G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1977. 17p. Dep. NTIS (US Sales Only), PC A02/MF A01.

In the fall of 1972, the nuclear ship OTTO HAHN was taken out of service in order to exchange the fuel elements and to take care of necessary modifications. Up to this time, she travelled a total distance of 241 588 nautical miles on 79 trips. The reactor plant was in service for approximately 25 230 h. The fuel elements reached a burn-up of 570 days. The guaranteed burn-up was exceeded by 14%. At sea the reactor was available 99.7% during operation. Operational data proved the design of the reactor plant to be very conserva-

tive. The fuel elements were never damaged. This successful operation of the FDR-reactor and its first core demonstrated that a reactor of this type is suitable for shipboard use.

12435 (GKSS—77/E/8, pp 93-127) **Void distribution in a ship reactor core at horizontal acceleration and its effect on reactivity.** Moritz, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). 1977. (In German).

From Specialist's meeting on the physics of feedback processes in nuclear reactors; Geesthacht, F.R. Germany (22 Jan 1976).

In Physics of feed back process in nuclear reactors.

At INTERATOM calculations for the reactor of the projected container ship 'NCS 80' have been carried out with the aim of assessing the reactivity changes with which the reactor reacts to accelerations in cross direction. Accelerations of the reactor are caused by sea motion. It must be ensured that the accelerations will not stimulate power fluctuations causing the reactor to scram and leading thus to immobilization of the ship. As the power fluctuations can be expected to become larger the larger the accelerations are, scram would occur when it would be least welcome because of the heavy sea. The study was done with the reactor simulator code ROSI and the thermohydraulic code DYNAMIT. Both programs can only treat steady states, and the cross acceleration was therefore assumed to be constant in time. This method is completely sufficient to get quantitative ideas on the reactivity effect of accelerations; all other things would not have been practicable because of the large expenditure. In this way, vertical accelerations have already been studied in earlier experiments. The attempt to also treat horizontal accelerations was new. Until now, the thermohydraulic code DYNAMIT has not been made to do this. The necessary model change has now been made.

12436 (GKSS—77/E/11) **NS Otto Hahn - test report No. 26. Refuelling 1976 and start-up test run.** (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1977. 28p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

Important technical innovations, preparatory activities concerning refuelling and the refuelling process are reported on. Further activities to be mentioned: internal in-service tests (visual inspection of the inner reactor pressure vessel), work on the main propulsion plant, the main condenser, and the in-core measuring equipment. Finally, the report informs of the start-up trial run in the North Sea (9th-25th August 1976).

12437 **Thermohydraulic feedbacks in self-pressurized reactor systems.** Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). *Atomkernenergie;* **29**: No. 3, 183-188(1977).

The impact on the dynamic behaviour of a self-pressurized reactor by the thermodynamic properties of the steam dome is investigated. For self-stabilization of the system the water of the primary circuit must be coupled thermodynamically to the steam in the steam dome, or alternatively the water in the reactor core must be subcooled sufficiently. Ways of thermodynamically coupling the water to the steam are heat conduction, boiling and condensation. A heat sink within the steam dome forces thermodynamic equilibrium between water and steam. This condition yields excellent self-control. Without heat sink thermal coupling is suspended at transients resulting in pressure rises. However, the reactor is still controlable as long as circuit and steam dome have direct contact. At the reactor of the NCS-80 a buffer volume of water separates primary circuit and steam volume. Stability is achieved by a heat sink in the steam dome and a shift of the core temperature into the subcooled domain effected by steam bubbles rising into the steam dome.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 11727, 12215, 12407, 13162

12438 (ANL—77-48) **Physics of reactor safety. Quarterly report, January—March 1977.** (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 57p. Dep. NTIS, PC A04/MF A01.

This report summarizes work done on reactor safety, Monte Carlo analysis of safety-related critical assembly experiments, and planning of DEMI safety-related critical experiments. Work on reactor core thermal-hydraulics is also included.

12439 (BMI-NUREG—1983) **Aerosol measurements and modeling for fast reactor safety. Quarterly progress report, April 1—June 30, 1977. Task 7.** Giescke, J.A.; Jordan, H.; Schmidt, E.W.; Lee, K.W.; Vaishnavi, B.; Reed, L.D. (Battelle Columbus Labs., Ohio (USA)). 28 Oct 1977. 24p. NTIS, PC A03/MF A01.

Technical efforts were concentrated on improving the HAARM-2 code primarily by adding the results of the sodium oxide agglomerate measurements, on formulating the mathematical basis for reference code development, on investigating the possibilities for using polynomials to express particle size distributions in the reference code, and on evaluating the use of a laser Doppler interferometry system to measure sodium oxide agglomerate sizes. Details of efforts performed and progress made on tasks in these several general areas are discussed.

12440 (BNL-NUREG—23143) **Non-equilibrium aspects of water reactor safety.** Jones, O.C. Jr.; Saha, P. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1977. Contract EY-76-C-02-0016. 76p. (CONF-771120—11). Dep. NTIS, PC A05/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, GA, USA (27 Nov 1977).

A critical review of the thermal non-equilibrium phase change models applicable to the water reactor safety calculations is presented. Four specific areas are discussed: (1) rapid depressurization (flashing), (2) post-dryout heat transfer, (3) direct contact condensation, and (4) sub-cooled boiling. The models have been judged from a mechanistic viewpoint, and the areas where further work is needed have been pointed out. It is suggested that when a phase change occurs due to a difference in the bulk fluid temperatures, the non-equilibrium phase change process can be viewed as a linear, non-homogeneous thermal relaxation phenomenon. Direct measurements of the actual phase change rates and the interfacial area densities are emphasized. Finally, a recommendation for the volumetric vapor generation rates applicable to the above four specific areas is given.

12441 (CONF-770708—1) **Simulation of the response of the Fort St. Vrain high temperature gas cooled reactor system to a postulated rod withdrawal accident.** Cleveland, J.C.; Hedrick, R.A.; Ball, S.J.; Delene, J.G.; Conklin, J.C. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From Thermal reactor safety meeting; Sun Valley, ID, USA (31 Jul 1977).

Transients resulting from the accidental withdrawal of a control rod pair from the Fort St. Vrain reactor core from 100% power conditions have been analyzed with the ORTAP nuclear steam supply system simulation. This analysis was done as part of an ongoing effort to obtain an independent assessment of the HTGR system response to several postulated accidents. Results are presented and discussed.

12442 (EURFNR—1460) **Thermodynamic state, specific heat, and enthalpy function of saturated UO_2 vapor between 3000 K and 5000 K.** Karow, H.U. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Feb 1977. 40p. (KFK—2390). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Euratom Fast Reactor Exchange Program.

Reactor safety analysis requires knowledge of the thermophysical properties of molten oxide fuel and of the thermal equation-of-state of oxide fuel in thermodynamic liquid-vapor equilibrium far above 3000°K. The thermodynamic state of saturated UO_2 fuel vapor, its internal energy U(T), specific heats C/sub v/(T) and C/sub p/(T), and enthalpy functions $H^{\circ}(H)$ and $H^{\circ}(T)-H_0^{\circ}$ have been determined by means of statistical mechanics in the temperature range 3000 to 5000°K. The discussion of the thermodynamic state includes the evaluation of the plasma state and its contribution to the caloric variables-of-state of saturated oxide fuel vapor. The resulting enthalpy functions and specific heats for saturated UO_2 vapor of equilibrium composition and that for pure UO_2 gas are compared with the enthalpy and specific heat data of gaseous UO_2 at lower temperatures known from literature. Tentatively also experimental enthalpy data of the condensed phases of UO_2 have been converted into the vapor phase using the Clausius-Clapeyron equation. However, the correlation based on the Clausius-Clapeyron equation turns out to fail because this equation is not applicable to the chemically reactive oxide fuel system.

12443 (GEAP—21304-4) **BWR blowdown/emergency core cooling. Fourth quarterly progress report, October 1—December 31, 1976.** Schneidman, B. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Jan 1977. vp. NTIS.

BD/ECC work completed in the fourth quarter of 1976 (October 1, 1976—December 31, 1976) is summarized. Publication of the 8 x 8 test plan, subcooled counter-current flow-limiting (CCFL) testing of 8 x 8 bundle upper tieplate, a number of scaling analyses, some modifications of TLTA and assembly of 8 x 8 BDHT bundle highlight the work completed.

12444 (GEAP-NUREG—21638) **BWR blowdown/emergency core cooling program: 64-rod bundle core spray interaction (BD/ECC1A) test plan.** Morrison, A.F. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Jun 1977. 49p. NTIS $4.00.

A test plan for the BD/ECC1A phase of the BD/ECC Test Program is presented. The test program will investigate system-core spray interaction under LOCA conditions in a scaled 218 BWR/6 test apparatus. Test parameters and ranges are selected; individual tests are defined and arranged in a test matrix; and measurement and data utilization plans are proposed.

12445 (IKE—2-35) **Simulation of the stationary and unstationary thermohydraulic processes in PWR reactors using RELAP 3 with the assumption of a forced lateral exchange between highly stressed core regions and core regions under normal stress.** Welhusen, B. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik). Mar 1976. 49p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The LOCA in PWR reactors is studied at the IKE using the code RELAP 3. In earlier calculations with RELAP 3, only the axial power density distribution was taken into account in determining core regions for code input, i.e. the core consisted of several control volumes connected in series. The influence of axial and radial power density distribution in the core on the stationary and instationary behaviour of the core of a PWR reactor is studied using RELAP 3.

12446 (KFK—2353) **TUFCI, an experimental facility to study the molten-fuel-coolant-interaction in a full scale fuel element.** Beutel, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Feb 1977. 66p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The safety-investigations for the Liquid-Metal-Fast-Breeder-Reactor also include experiments for fuel-coolant-interactions (FCI) in a simulated fuel element to find out the conversion factor from thermal to mechanical energy. This report describes the development of an experimental facility which makes it possible to produce an FCI in a geometry, which is typical for a fuel element. Other then in real elements the wall of the reaction tube is rigid. Fuel-sodium contact is achieved by the impact of sodium and molten UO_2 as well as by the injection of smaller quantities of sodium into UO_2 (initiating-reaction). Finally an experiment is described in which smaller quantities of sodium were injected into liquid fuel.

12447 (KFK-EXT—8/76-1) **Blowdown tests performed in the KWU test facility in Karlstein.** Schnauder, H.; Cramer, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Feb 1977. 98p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

From June to August 1975 the Kernkraftwerk Union in Karlstein performed blowdown tests relating to the dynamic behaviour of pressure-suppression system of boiling water reactors during loss-of-coolant accidents. Part of the blowdown channels used had the same dimensions as used in the BWR-line 69 (600 mm ID). The Institute of Reactor Development participated in these tests with its own instrumentation for pressure measurement. The report describes the test facility and the test performance and gives a survey of the pressures measured as a function of time. In addition, the report contains preliminary results of three-dimensional attenuation and of propagation rates of pressure pulses in the water pool.

12448 (KFK-EXT—8/76-4) **LMFBR post accident heat removal testing needs and conceptual design of a test facility.** Kleefeldt, K.; Kuechle, M.; Royl, P.; Werle, H.; Boenisch, G.; Heinzel, V.; Mueller, R.A.; Schramm, K.; Smidt, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung). Mar 1977. 196p. Dep. NTIS (US Sales Only), PC A09/MF A01.

A study has been carried out in which the needs and requirements for a test facility were derived, enabling detailed investigation of key phenomena anticipated during the post accident heat removal (PAHR) phase as a consequence of a postulated LMFBR whole core accident. Part I of the study concentrates on demonstrating the PAHR phenomena and related testing needs. Three types of experiments were identified which require in-pile testing, ranging from 10 to 70 cm test bed diameter and correspondingly, 30 to 5 W/g minimum power density in the test fuel. In part II a conceptual design for a test facility is presented, emphasizing the capability for accomodating large test beds. This is achieved by a below-reactor-vessel testing device, neutronically coupled to a 100 MWt sodium cooled fast reactor.

12449 (LA—5978-MS) **Study of fast reactor safety test facilities. Preliminary report.** Bell, G.I.; Boudreau, J.E.; McLaughlin, T.; Palmer, R.G.; Starkovich, V.; Stein, W.E.; Stevenson, M.G.; Yarnell, Y.L. (Los Alamos Scientific Lab., N.Mex. (USA)). May 1975. Contract W-7405-ENG-36. 381p. Dep. NTIS, PC A17/MF A01.

Included are sections dealing with the following topics: (1) perspective and philosophy of fast reactor safety analysis; (2) status of accident analysis and experimental needs; (3) experiment and facility definitions; (4) existing in-pile facilities; (5) new facility options; and (6) data acquisition methods. (DG)

12450 (LA-NUREG—6842-PR) **Nuclear reactor safety. Quarterly progress report, January 1—March 31, 1977.** Jackson, J.F. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1977. Contract W-7405-ENG-36. 123p. Dep. NTIS, PC A06/MF A01.

Research progress is reported under the following headings: LWR safety research, LMFBR safety research, HTGR safety research, GCFR core disruptive test program, and containment system studies and evaluation.

12451 (LA-UR—77-1995) **Physically based analytical model for predicting HTGR seismic response.** Bennett, J.G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-770929—2). Dep. NTIS, PC A02/MF A01.

From Seminar on HTGR safety technology; Upton, NY, USA (15 Sep 1977).

An analytical model is described that was developed to predict the seismic response of large High Temperature Gas-Cooled Reactor cores. Applications of the model are listed and discussed.

12452 (MRR—160, pp 559-571) **Safety evaluation experience with digital computer software.** Beltracchi, L.; Bullock, J.B. (Nuclear Regulatory Commission, Washington, D.C. (USA); Oak Ridge National Lab., Tenn. (USA)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 6: software for protection systems.

The use of digital computers in a reactor protection system presents new design considerations for the designers of both the reactor and the safety system. Experiences in the safety evaluation of protection system software are discussed in terms of guidelines that were developed, the importance of the software development cycle, and the application of the guidelines. The important guidelines such as critical design faults and qualitative reliability are currently being used for evaluation purposes. Minimum requirements for the design qualification and acceptance testing of the software have been identified. The safety review is incomplete. However, most of the protection algorithms, test plans, and some test results have been reviewed.

12453 (MRR—160, pp 41-50) **Formation of safety parameters with the digital calculating module.** Oeder, K. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 1: plant supervision and disturbance analysis.

The trip conditions Departure from Nucleate Boiling Ratio (DNBR) and Offset serve the protection of the reactor core against damage of fuel elements. The trip conditions are formed by several analog variables in dependence on the respective main coolant pump status. The complexity of signal combination and the demand for high signal processing accuracy require the use of a digital calculating module. Four digital calculating modules are redundantly integrated with the local coincidence logic of the reactor trip system and are monitored continuously for accidental failures. The analog input signals of the digital module are converted into a binary code. The output signals of the calculating module are again analog. The digital calculating module is constructed by use of time-tested integrated components. The positive results of a longterm test of the modules to be finally installed and of a failure mode and effect analysis are basis for the approval of the modules by the licensing authority.

12454 (MRR—160, pp 617-624) **Chairman's report: software for protection systems.** Patterson, E.S.; Ehrenberger, W. Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 6: software for protections systems.

The present paper summarizes the contributions to session VI: 'Software for Protection Systems' of the IAEA/NPPCI Specialists meeting on use of computers for protection systems and automatic control.

12455 (MRR—160, pp 481-490) **Design study for a computer-based system for fast reactor protection.** Thomasson, R.K.; Kneller, B. (Nuclear Power Co. Ltd., Risley (UK)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 5: computers in plant protection.

This paper reports on initial design investigation for a computer based safety system intended to provide reactor trips by the detection of abnormal behaviour of the outlet temperature of core fuel sub-assemblies. The system scans the 6 x 550 outlet temperature thermocouples of the reactor and generates trip signals (or more correctly fails to generate hold up pulses to the reactor protection system guard lines) on detection of either of the following events. 1) That the measured outlet temperature differs by more than a specified margin from a slaved, rate limited reference for period of 50 milliseconds. 2) That the measured outlet temperature differs by a specified margin from a reference calculated on the assumption that the sub-assembly outlet temperature should conform to a pattern.

12456 (MRR—160, pp 585-597) **Aspects of the design and verification of software for a computerized reactor protection system.** Voges, U. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 6: software for protection systems.

In contrary to hardware, software lasts forever. If software is considered to be correct, it remains correct all the time (except you make any changes to it). Therefore failure rates, MTBF, MTTR etc. cannot be used for software. The main effort has to be put on: 1) how to make reliable software, 2) how to prove software to be correct. The first part deals with the developmental stage, the specification, design and implementation of the software, the second part with the 'produced' software, its test and verification.

12457 (MRR—160, pp 573-584) **Design features of the fuel element computerized protection system Bessy.** Juengst, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). Jul 1976.

From IAEA/NPPCI specialists meeting on use of computers for protection systems and automatic control; Neuherberg/Munchen, F.R. Germany (11 May 1976).

In Proceedings of the IAEA/NPPCI specialists' meeting on use of computers for protection systems and automatic control. Session 6: software for protection systems.

In the LMFBR SNR 300 a process computer will be applied as a subsystem of the reactor protection system. It is to detect plugging fuel elements by monitoring the outlet temperatures of the 205 subassemblies. The system consists of four computers, three with 2 out of 3 majority voting for the task of engineered safeguards and one for the information output. The presentation describes the structural design of hard- and software and discusses some safety related features which may be considered by further integration of computers in reactor protection systems.

12458 (MRR—166) **Conclusions drawn from reliability analyses of reactor protection systems.** Nieckau, E. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)). Nov 1976. 40p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

This report summarizes the experiences which are gained with reliability analyses of reactor protection systems. Considerations are given to the procedure of these analyses and also to the rules for possible ommissions. Furthermore, parameters influencing their construction are discussed. This report deals particularly with the analyses of hard-wired reactor protection systems, whereas the protective computers are simply mentioned.

12459 (NEDO—10174(Rev.1)) **Consequences of a postulated flow blockage incident in a boiling water reactor.** (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Oct 1977. vp. Electric Co., San Jose, CA.

The effects of a fuel bundle flow blockage in a boiling water reactor have been investigated. The consequences in terms of fuel damage, fission product release, local high-pressure production, and possible propagation to adjacent assemblies have been evaluated. The conclusions reached are that a flow blockage incident will not result in local high-pressure production, propagation to adjacent assemblies, or off-site doses in excess of small fractions of 10CFR100 guidelines.

12460 (NEDO—21175-2) **BWR/6 fuel assembly, evaluation of combined safe shutdown earthquake (SSE) and loss-of-coolant accident (LOCA) loadings (amendment No. 2).** (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Sep 1977. 68p. Electric Co., San Jose, CA.

Responses to questions concerning the evaluation of combined safe shutdown earthquake and loss-of-coolant accident loadings on BWR/6 fuel assemblies are presented.

12461 (ORNL/NUREG—23) **ORINC: a one-dimensional implicit approach to the inverse heat conduction problem.** Ott, L.J.; Hedrick, R.A. (Oak Ridge National Lab., Tenn. (USA)). 18 Oct 1977. Contract W-7405-ENG-26. 289p. Dep. NTIS, PC A13/MF A01.

The report develops an implicit solution technique to determine both the transient surface temperature and the transient surface heat flux of electrically heated rods given the power input and an "indicated" internal temperature during a simulated loss-of-coolant accident. A digital computer program ORINC (ORNL Inverse Code) is developed which solves a one-dimensional, transient, lumped parameter, implicit formulation of the conduction equation at each bundle thermocouple position in the Thermal-Hydraulic Test Facility (THTF).

12462 (ORNL/NUREG/NSIC—139) **LMFBR safety. 5. Review of current issues and bibliography of literature (1975—1976).** Buchanan, J.R.; Keilholtz, G.W. (Oak Ridge National Lab., Tenn. (USA)). 8 Jun 1977. Contract W-7405-ENG-26. 575p. (ORNL/NUREG/NSIC—125(Vol.5)). Dep. NTIS, PC A25/MF A01.

The current status of liquid-metal fast breeder reactor (LMFBR) development and one of the principal safety issues, a hypothetical core-disruptive accident (HCDA), are discussed. Bibliographic information on worldwide LMFBRs relative to the development and safety of the breeder reactor is presented for the period 1975 through 1976. The bibliography consists of approximately 1618 abstracts covering early research and development and operating experiences leading up to the present design practices that are necessary for the licensing of breeder reactors. Keyword, author, and permuted-title indexes are included for completeness.

12463 (ORNL/NUREG/NSIC—142) **Reports distributed under the NRC Light-Water Reactor Safety Research Foreign Technical Exchange Program. Volume III, January—June 1977.** Sharp, D.S.; Cettrell, W.B. (Oak Ridge National Lab., Tenn. (USA)). 19 Sep 1977. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

Lists of documents exchanged during the first half of 1977 under agreements between the U.S. Nuclear Regulatory Commission's Office of Nuclear Regulatory Research and the governments of France, Federal Republic of Germany, and Japan are presented. During this period, the NRC received 41 reports from France, 29 from F. R. Germany, and 24 from Japan, and in return sent 107 U.S. reports to each of these three countries.

12464 (RISO—344) **Analysis of control rod ejection accidents in large boiling water reactors.** Thorlaksen, B. (Risoe National Lab., Roskilde (Denmark)). Nov 1976. 136p. Dep. NTIS (US Sales Only), PC A07/MF A01.

Expressions are evaluated for the control rod velocity as the hydraulic pressure inside the control rod guide tube during a rod ejection accident and a rod drop accident. For the rod ejection transients, the effectiveness of the control rod velocity limiter is found to be strongly dependent on the discharge flow from a postulated rupture of the control rod drive thimble. The nuclear transient is analysed by means of the three-dimensional dynamic BWR simulator DANAID, which is based on nodal technique. The kinetics equations are written in modified one-energy group theory. Both Doppler feedback and moderator feedback are incorporated in the program. The Doppler effect is expecially strong, but because of the power directly deposited in the coolant the moderator feedback is also significant and rapid. Removal of 2% $\Delta k/k$ rod, with a velocity corresponding to the maximum drop velocity of a General Electric control rod, should not result in any significant damage to the reactor system. The result of the rod ejection analysis is a maximum fuel enthalpy below the fracture thresholds. However, the hot channels are voided and the radioactivity from 800-1200 fuel rods is released to the coolant.

12465 (SAND—77-1096C) **First in-core molten fuel pool experiment.** Plein, H.G.; Carlson, G.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 5p. (CONF-771109—36). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

If during a LMFBR accident a fuel debris bed is not adequately cooled by overlying sodium and dryout occurs, then the fuel would heat up and melt. Molten fuel pools are of concern due to their potential for ablation of the supporting structure and possible penetration of the reactor vessel. The major goal of the molten fuel pool program has been to develop a versatile experiment in which heat flux and structural ablation could be studied using real materials under typical temperature and heating conditions. This has now been accomplished, using the Annular Core Pulse Reactor (ACPR) to fission heat enriched UO_2. In the first experiment conducted, a small portion of a 0.834 kg UO_2 sample was melted, and temperature data were recorded to above the melting point of the UO_2 using ultrasonic thermometry.

12466 (SRD-R—72) **Finite element structural analysis code SAP IV conversion from CDC to IBM.** Harrop, L.P. (UKAEA Safety and

Reliability Directorate, Culcheth). Feb 1977. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

SAP IV is a general three dimensional, linear, static and dynamic finite element structural analysis program. The program which was obtained from the Earthquake Engineering Research Center, University of California, Berkeley, was written in FORTRAM for a CDC 6400. Its main use was anticipated to be the seismic analysis of reactor structures. SAP IV may also prove useful for fracture mechanics studies as well as the usual elastic stress analysis of structures. A brief description of SAP IV and a more detailed account of the FORTRAN conversion required to make SAP IV run successfully on the UKAEA Harwell IBM 370/168 are given.

12467 (TREE—1110) **Instrumentation and Control Division annual report.** Stanley, M.L. (EG and G Idaho, Inc., Idaho Falls (USA)). Apr 1977. Contract EY-76-C-07-1570. 130p. Dep. NTIS, PC A07/MF A01.

The report presents a summary of accomplishments in instrumentation-related activities involving research and development, testing and evaluation, assembly, and application in support of ERDA and NRC programs, LOFT, Test Fuels Behavior Program, and Semiscale. Developmental work in ultrasonic thermometry, modular microprocessor systems, and thermocouple attachment techniques on refractory metals is covered. Tests and modifications on transducers are looked at. Assembly of various transducers, instrumented fuel rods, and safety systems for reactors are addressed. Research in measurement of various reactor coolant flows is referenced.

12468 (TREE-NUREG—1117) **Investigation of alternate ECC injection concepts in the semiscale Mod-1 system.** Harvego, E.A.; Peterson, A.C.; Loomis, G.G.; Hanner, O.M. (EG and G Idaho, Inc., Idaho Falls (USA)). Sep 1977. Contract EY-76-C-07-1570. 202p. Dep. NTIS, PC A10/MF A01.

The potential benefits and relative merits of four alternate emergency core coolant (ECC) injection concepts are investigated in the Semiscale Mod-1 system. The major controlling thermal-hydraulic phenomena associated with the effectiveness of each alternate ECC injection concept are also examined. The principal means used to evaluate the various concepts is a comparative analysis of experimental data for a given concept (from Test Series 5) with data from a baseline cold leg ECC injection test (Test S-04-6), run as part of a prior test series, and with data from other tests in the alternate ECC injection test series. As a result of this investigation conclusions pertaining to the effectiveness of the different concepts in the Semiscale Mod-1 system are reached, and the relative merits of the concepts are identified.

12469 (TREE-NUREG—1148) **Experiment data report for Semiscale Mod-1 Test S-28-1 (steam generator tube rupture test series).** Collins, B.L.; Coppin, C.E.; Sackett, K.E. (EG and G Idaho, Inc., Idaho Falls (USA)). Oct 1977. Contract EY-76-C-07-1570. 293p. Dep. NTIS, PC A13/MF A01.

Recorded test data are presented for Test S-28-1 of the Semiscale Mod-1 steam generator tube rupture test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Test S-28-1 was conducted from initial conditions of 15 767 kPa and 557 K to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the broken loop cold leg piping. During the test, cooling water was injected into the cold leg of the intact and broken loops to simulate emergency core coolant injection in a PWR. Sixty steam generator tube ruptures were simulated by a controlled injection from a heated accumulator into the intact loop hot leg.

12470 (UCID—17606) **Calculated volumes and internal surface areas Mark I 1/5-Scale BWR Pressure Suppression Facility (LLL).** Sterbentz, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Aug 1977. Contract W-7405-ENG-48. 40p. Dep. NTIS, PC A03/MF A01.

The report contains calculated volumes and internal surface areas for the vent pipes and ringheader assemblies from the Mark I 1/5-Scale Boiling Water Reactor Pressure Suppression Facility. Specifically, the calculated volumes and surface areas included the component sections of the vent pipes, ringheader and downcomers in both the 7.5° and 45° torus sectors.

12471 (UCRL—50016-77-2, pp 1-7) **NRC reactor-safety research project: BWR Mark I.** McCauley, E.W.; Pitts, J.H. 30 Jun 1977. In Mechanical Engineering Department quarterly report, April—June 1977.

The design-basis loss-of-coolant accident (LOCA) for light-water nuclear reactors postulates a major break in a coolant line. The response of the pressure-suppression containment system exterior to the pressure vessel following such an event is important to reactor safety. The Nuclear Regulatory Commission funded LLL to design and build a 1/5-scale experimental facility modeling the pressure-suppression containment system of a Mark I boiling water reactor and to conduct tests simulating a LOCA. We are currently analyzing results from a series of 27 air tests conducted at the facility and are preparing for steam tests. Extensive laboratory-size experiments have been conducted to improve the understanding of the physical observables as well as to establish the validity of scaling laws extending the data from the 1/5-scale tests to a full-scale facility.

12472 (WCAP—7820(Suppl.7)) **Electric hydrogen recombiner LWR containments. Supplemental test number 2.** Wilson, J.F. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Oct 1977. 22p. Electric Corp., Pittsburgh, PA.

The Westinghouse Electric Corporation has developed, tested, and produced an electric hydrogen recombiner for installation inside reactor containment for use following a postulated loss-of-coolant accident. This report provides qualification test results for the recombiner power cable (located inside the containment), the recombiner control and power supply panels (located outside the containment) and additional features which may be selected by the customer. Also included are results of testing which further demonstrate the conservative design of the recombiner.

12473 (WCAP—9194) **Seismic qualification of the rotary relay for use in the Trojan and Diablo Canyon Auxiliary Safeguards Cabinets.** Riggio, M.D.; Jarecki, S.J. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA)). Oct 1977. 81p. Electric Corp., Pittsburgh, PA.

This report presents the results of the analysis performed for the seismic qualification of the rotary relay for use in the Trojan and Diablo Canyon Auxiliary Safeguards Cabinets. A finite element model of the cabinet was developed from seismic test results. This model was analytically subjected to a simulated 3D floor acceleration time history that enveloped, simultaneously, the Trojan and the June 1969 Diablo Canyon Safe Shutdown Earthquake requirements. The dynamic response of the cabinet at the mounting location of the rotary relays was determined. The calculated acceleration time histories were converted to response spectra and these response spectra were compared to the test response spectra successfully achieved during the rotary relay seismic qualification tests. It was found that the dynamic motion levels at the rotary relays, when mounted in the Trojan or Diablo Canyon Auxiliary Safeguards Cabinets, do not exceed the levels for which they were previously seismically qualified by tests. Consequently, the rotary relays are seismically qualified for use in the Trojan or Diablo Canyon Auxiliary Safeguards Cabinets.

12474 (ZAED-tr—77/1) **Basic principles of the prevention of radiation exposure of personnel and population during nuclear power plant accidents.** Turkin, A.D.; Sayapin, N.P.; Turovskii, V.D.; Luzanova, L.M. (Zentralstelle fuer Atomkernenergie-Dokumentation (ZAED), Eggenstein-Leopoldshafen (Germany, F.R.)). 1977. 13p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The developments in nuclear engineering and the erection of nuclear power plants in densely populated areas make it necessary to draw up and apply special measures for the protection of the operating personnel, the population and the environment during the various states of operation of a nuclear power plant. Safe operation of nuclear power plants without radiation hazards is guaranteed by intensive and complex technical, medical, and organisational measures. The paper points out the main tendencies for the protection of the personnel exposed to radiation and of the population in cases of nuclear power plant accidents. These accidents fall into five categories which must be taken into consideration already in the planning stage and during power plant operation. Some questions of the application in practice of necessary accident prevention measures are dealt with. The reliability and unproblematic nature of existing nuclear power plants with regard to radiation hazards is stressed.

12475 (ANL-Trans—1106) **Autonomous device for after-heat removal from a sodium cooled fast neutron reactor.** Oct 1977. Translation of French Patent Application No. 7,335,223. 11p. Dep. NTIS, PC A02/MF A01.

An autonomous device is described for removal of the after-heat in a sodium-cooled fast reactor of the type in which each cooling loop comprises the primary sodium circuit exchanging its heat with the sodium of a secondary circuit through an intermediate exchanger, characterized by the fact that each cooling loop in parallel with the secondary sodium circuit contains an auxiliary secondary circuit in which a chemically inert gas draws heat from the primary circuit, said auxiliary secondary circuit comprising at least one gas turbine fed by said inert gas and operating in an energy-generating closed cycle.

12476 **Using butterfly valves for PWR containment isolation.** Hancock, V. (Fisher Controls Co). *Power Eng.;* **81**: No. 8, 61-63(Aug 1977).

Containment isolation is a distinctive feature of the pressurized water reactor. There are many system penetrations of the containment vessel and each of these lines uses redundant isolation valves to guarantee tight sealing of the vessel should a loss-of-coolant accident occur. It is shown that if these valves are classified as active, they must be designed to meet dynamic torque considerations and documented to substantiate their operability. But if they are nonactive and not subject to flow during the pressure drop of a loss-of-coolant emergency, a considerable cost savings can result.

12477 Objectives and present status of the German risk evaluation study. Birkhofer, A.; Koeberlein, K. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Garching/Muenchen (Germany, F.R.)); Heuser, F.W. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 6, 331-338(Jun 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

For the German risk evaluation study, analogous to the Rasmussen report (WASH--1400), embarked upon in June 1976, the Kernkraftwerk Biblis B serves as the plant of reference. The first interim results are available for various sub-headings of the study. The main finding seems to be the decisive importance of the containment in limiting the accident consequences even in those cases where, on account of postulated failure of safety systems, the melt down of the reactor core is to be expected.

12478 Characteristics of a risk analysis for the site of an Austrian nuclear power plant. Kumer, L. (Kernkraftwerk-Planungsgesellschaft m.b.H., Vienna (Austria)). *Atomwirtsch., Atomtech.;* **22**: No. 5, 276-280(May 1977). (In German).

In the present article, the risk calculations of the Rasmussen report (WASH-1400) are revised with a view to Austrian conditions. Alterations in the population density, atmospheric diffusion conditions, and reactor safety engineering are taken into account. This results in a lower risk concerning nuclear engineering as compared with the American study for the prospective site of Stein/St. Pantaleon.

12479 Safety specifications for power plants. Origin - significance, contents and form - information on the elaboration. Fechner, J.B.; Wildberg, D.W. *Tech. Ueberwach.;* **18**: No. 4, 111-116(Apr 1977). (In German).

A highly-trained staff with the necessary training and competence, an organisation according to the needs of operation and safety and clear extensive ragulations for all relevant operational and disturbance situations are essential preconditions for the safe operation of a nuclear facility which also serve directly to protect the staff. The authorities of the Laender competent for the atomic law and the Ministry of the Interior have agreed to have all data, limiting values, and measures of each nuclear power plant necessary for its safety and its safe operation compiled in a document. This is to improve the possibility of assessing the safety characteristics of the nuclear power plant and to ensure its safe operation by the staff. After the representation of the development of the safety specifications, the focal points are explained. The system prepared for light water reactors can also be applied to other types of reactors.

12480 Safety requirements for nuclear power stations. XII. Investigations and measures in case of accidents. Hoffmeister, N. (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 4, 2, 4(Apr 1977). (In German).

The article deals with the following questions: Which type of testing is to be carried out in the case of major accidents and, if necessary, which type of orders is to be given in order to avoid a repetition and which method is to be applied for checking as to whether the cause of the accident is of far-reaching importance.

12481 Phenix intermediary heat exchanger intervention. Conte, F. (CEA Centre de Marcoule, 30 - Bagnols-sur-Ceze (France). Service de la Centrale Phenix). *Rev. Gen. Nucl.;* No. 1, 57-59(Jan-Feb 1977). (In French).

Operation on Phenix intermediary heat exchangers after the July and October 1976 incidents is analyzed. Included are remarks on conditions of repair work.

12482 Forecast of the atmospheric diffusion of pollutants after hypothetical accidents at nuclear plants. Vogt, S. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Strahlenschutz und Sicherheit). *Atomkernenergie;* **29**: No. 4, 282-286(1977). (In German).

The forecast of atmospheric diffusion described here allows statements to be made about the size and location of the area in which maximum radiation burdens have to be expected from emission after an accident. If the source strength can be estimated from the course of the accident, the value of the maximum burden to be expected can be predicted in addition. Based on these statements, first effective actions can be taken to protect the population in case of serious hypothetical accidents.

12483 Concrete containments and the ASME Code, Section III, Division 2. Walser, A. (Sargent and Lundy, Chicago, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 77-PVP-24, 1-9(1977).

This paper is intended to give a general overview of the code requirements for reinforced and prestressed concrete containments as they compare in principle to code requirements for steel containments. It discusses, in general terms, the new ASME Code, Section III, Division 2. Similarities and differences in ASME codes concerned with steel containments are pointed out. Similarities include general requirements and provisions for steel components. Differences include requirements for concrete materials and construction, and design as well as analysis.

12484 Application of NE-3000 rules. Strunk, J.F. (Pittsburgh-Des Moines Steel Co, Pa). *Am. Soc. Mech. Eng., [Pap.];* No. 77-PVP-25, 1-4(1977).

The ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NE, Article NE-3000, Design, has recently been revised to clarify and reflect a design by analysis approach for containment vessels. The criteria and application of these analytical procedures are presented in this paper in light of stress report requirements of Section III of the ASME Boiler and Pressure Vessel Code. Emphasis is placed on the requirements of NE-3200. 5 refs.

12485 (JAPFNR—259) Study on sodium void reactivity worth predictional method. Kamei, T.; Yoshida, T.; Murakami, K.; Iijima, S. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan); Nippon Atomic Industry Group Co. Ltd., Kawasaki, Kanagawa. Nuclear Research Lab.). Nov 1976. Translation of N—251-76-28. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Japanese Fast Reactor Exchange Program.

The accurate evaluation of sodium void reactivity of a fast breeder reactor is of great importance in connection with a reactivity addition at high rates, which could cause a large nuclear energy release, in a hypothetical sodium loss accident. However, the complexity of the phenomena has prevented a reliable estimation of the sodium void reactivity worth. This paper presents a detailed analysis of sodium void experiments and assesses the adequacy of the calculational method, and then predicts the sodium void reactivity worth of the Japanese proto-type fast breeder reactor MONJU.

12486 Approximate analytical method for the dynamic responses of the elasto-plastic structures. Fujikawa, T. (Kobe Steel Ltd. (Japan)). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 362, 3076-3085(Oct 1976). (In Japanese).

The sufficient examination of aseismatic strength mainly by dynamic analysis is required in design stage for the important equipments in nuclear and chemical plants. The method of aseismatic design is explained in detail in "Technical guide to the aseismatic design of nuclear power stations". However, the methods of the analysis taking the elasto-plastic properties of materials into account carried out so far are not satisfactory from the standpoint of design. In this paper, for the purpose of analyzing the seismic response of beam structures, the attempt to obtain the approximate response was made from the practical standpoint, and the results are reported. The theory of elasto-plastic analysis and the seismic responses with one degree of freedom, non-linear model and with one degree of freedom, elasto-plastic model are explained. In order to examine the propriety of the elasto-plastic analysis of multiple degrees of freedom systems, lead material, which shows the elasto-plastic property at normal temperature, was oscillated sinusoidally or randomly, and the comparison with the results of analysis was made. The agreement was considerably well, and the prospect that this analytical method can be practically used was obtained. The method of estimating equivalent Young's modulus and loss coefficient from static tensile curves is also shown.

12487 Reactor. Ichiki, T.; Machiba, H. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1976-132,394/A/. 13 May 1975. 3p. (In Japanese).

The object is to mount a pressure vessel pedestal on a soft-construction base board in such a manner so as to form a cabin or gap thereby reducing the weight of support structure and absorbing vibrations and shocks produced at the time of earthquake. The pressure vessel pedestal, to which a reactor pressure vessel is attached, is supported by the soft-construction base board, and various vessels are disposed within an outer frame through the gap and cabin.

12488 Energy absorbing device. Shindo, Y. (to Kawasaki Heavy Industries Ltd., Kobe (Japan)). Japanese Patent 1976-114,590/A/. 1 Apr 1975. 3p. (In Japanese).

The object is to absorb abnormally high energy when it is generated within a reactor container or steam generator to prevent the reactor container or steam generator from being destroyed. A low strength portion, which is smaller in strength than other parts of a main body, is provided in a part of the container main body generating an abnormal pressure, the low strength portion being

externally provided with an energy absorber, on the outside of which a casing is mounted, the energy absorber being retained in a predetermined position of the main body.

12489 Emergency cooling system in a reactor. Miki, K.; Inoue, K. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1976-104,199/A/. 12 Mar 1975. 3p. (In Japanese).

The object is to cool a core by securely operating a heat pipe when fuel is replaced or in an emergency. A heat pipe is annularly arranged upwardly of a reactor container in a manner so as not to hamper insertion of a fuel rod. This heat pipe is connected to a heat radiating system and is sealingly filled with Li, Na, K, NaK or the like as a heating medium. Normally, inert gases are sealed in the heat pipe to prevent vaporization of the heating medium, thus preventing heat discharge. Also, in emergency, the inert gases are extracted so that the heating medium abstracts heat from the interior of the reactor and is vaporized, condensed in the heat radiating system and recirculated within the heat pipe by means of the force of capillary action. Such vaporization, condensation and recirculation are repeated to cool the interior of the reactor.

12490 Calculations of combined radiation and convection heat transfer in rod bundles under emergency cooling conditions. Sun, K.H.; Gonzalez, J.M.; Tien, C.L. (GE, San Jose, Calif). *Am. Soc. Mech. Eng., [Pap.]*: No. 75-HT-64, 9(1975).

A model has been developed to calculate the heat transfer coefficients from the fuel rods to the steam-droplet mixture typical of Boiling Water Reactors under Emergency Core Cooling System (ECCS) operation conditions during a postulated loss-of-coolant accident. The model includes the heat transfer by convection to the vapor, the radiation from the surfaces to both the water droplets and the vapor, and the effects of droplet evaporation. The combined convection and radiation heat transfer coefficient can be evaluated with respect to the characteristic droplet size. Calculations of the heat transfer coefficient based on the droplet sizes obtained from the existing literature are consistent with those determined empirically from the Full-Length-Emergency-Cooling-Heat-Transfer (FLECHT) program. 14 refs.

12491 Thermal behavior of densification power spiked PWR fuel rods during a LOCA. Hellman, J.M.; Olson, C.A.; Yang, J.W. (Westinghouse Electr Corp, Pittsburgh, Pa). *Am. Soc. Mech. Eng., [Pap.]*: No. 75-HT-67, 8(1975).

During irradiation in light water reactors, the UO$sub 2$ pellets constituting the fuel loading have been observed to increase in density by, at most, a few percent. If any of the $similar$240 pellets stacked in each of the $similar$40,000 tubes in a typical Westinghouse pressurized water reactor become "hung up" in the tubing before the densification process is complete, an interpellet gap is formed in the fuel column. Gaps such as these have been observed in operating reactors. Physics calculations show that the removal of a neutron absorbing material (e.g., the fuel) from a localized region of the core (e.g., a gap) causes power spiking on the fuel pellets near the gap. Limits of operation of a LWR are partially determined by the peak clad temperatures reached during the hypothetical loss of accident (LOCA). The effect on clad temperatures of the local power spikes due to densification gaps during the LOCA transient is analyzed. 7 refs.

12492 Coupled bending and torsional response of nuclear power plant structures to earthquake loading. Bahar, L.Y.; Ali, S.A. (United Eng and Constr, Inc, Philadelphia, Pa). *Am. Soc. Mech. Eng., [Pap.]*: No. 75-DET-52, 1-9(1975).

Torsional effects in nuclear power plants are considered which arise because of the nonuniform mass distribution of the equipment at various floor levels, lack of symmetry of the building assembly due to auxiliary buildings, or an uneven distribution of the stiffness of lateral load carrying members. A method by which the capability of a general purpose computer program can be used to accommodate the coupled bending-torsion analysis is developed, and its validity is verified by means of an analytical formulation and solution of sample problems. 12 refs.

12493 Seismic environment for nuclear power plant components--an interface problem. Hadjian, A.H.; Jan, H.W.; Linderman, R.B. (Bechtel Power Corp, Norwalk, Calif). *Am. Soc. Mech. Eng., [Pap.]*: No. 75-DET-53, 1-12(1975).

Federal regulations require that nuclear power plant structures, systems and components important to safety be designed to function during and following a postulated Safe Shutdown Earthquake. Thus, seismic induced vibrations become one of the major factors affecting the design of these plants. Numerous interface problems exist during the design and construction stages. The paper attempts to describe the present state-of-the-art regarding the interface problems generated only by the requirements of seismic qualification of all safety-related structures, systems and components. Recommendations are made to improve the present situation. 7 refs.

ACCIDENT LIABILITY

12494 (AAEC/IP—12) **Third party liability for nuclear damage.** Crancher, D.W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1976. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Basic principles of nuclear liability legislation are discussed including absolute and limited liability and the role of the Sovereign State in idemnifying the operator for damage in excess of limited liability. European counrties realised the need for unifying the law of nuclear instability and efforts were made accordingly towards producing workable international conventions. The world's first legislation on nuclear liability - the USA Price-Anderson Act - is described in detail and a digest of nuclear liability claims experience is given. Observations of the present status of nuclear third party liability are outlined.

12495 Twentieth anniversary of German nuclear reactor insurance pool. Hertel, G. (Deutsche Kernreaktor-Versicherungsgemeinschaft, Koeln (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 7, 423-424(Jul 1977). (In German).

When the peaceful utilization of nuclear energy was launched, insurance companies in the countries concerned faced a risk whose magnitude intially was unfathomable and for whose assessment they were not experienced enough, either with respect to the hazard probability or the potential extent of a damage. For this reason a pool, an association on a pro rata base, was organized on a national level by all insurance companies willing to offer coverage. In addition, to further spread the risk, worldwide mutual cooperation was agreed upon among the national pools. The 107 companies which presently make up the German pool cooperate with pools in twenty other countries.

12496 New Liability Coverage Ordinance. Winters, K.P. (Bundesministerium des Innern, Bonn (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 7, 396-398(Jul 1977). (In German).

Since the Paris Nuclear Liability Agreement and the Third Amendment to the German Atomic Energy Act entered into force, nuclear liability law in the Federal Republic of Germany has been organized on a new basis. The new Liability Coverage Ordinance, which entered into force February 1, 1977, was designed to adapt the law of liability coverage to the current state of development and, in addition, takes into account the inclusion of new licensing and liability elements in the Fourth Amendment to the German Atomic Energy Act.

12497 20 years of Deutsche Kernreaktor-Versicherungsgemeinschaft. Hertel, G. *Versicherungswirtschaft;* **32**: No. 10, 648-651(May 1977). (In German).

A survey is presented of the coming into being and the present state of the 'pool', a risk joint company, organized on a national level, of all insurance enterprises offering financial security on a proportional basis (DKVG = Deutsche Kernreaktor-Versicherungsgemeinschaft (German nuclear reactor cooperative insurance company)), and of cooperation with insurance pools of other western countries.

ENERGY STORAGE

REFER ALSO TO CITATION(S) 12547, 12571, 12630, 12634

MAGNETIC

REFER ALSO TO CITATION(S) 13513

COMPRESSED GAS

REFER ALSO TO CITATION(S) 12560

PUMPED HYDRO

REFER ALSO TO CITATION(S) 11916

12498 Caverns at Dinorwic. *Consult. Eng. (London);* **41**: No. 6, 46-47, 49(Jun 1977).

The paper reports that the Dinorwic pumped storage scheme in North Wales will serve principally as reserve capacity to improve the reliability of the electricity grid in England and Wales. Six reversible pump/turbine sets will be installed each with a nominal capacity of 300 MW. The article is concerned with the design of the

group of caverns that form the underground power and pumping plant.

FLYWHEELS

REFER ALSO TO CITATION(S) 12805

12499 (Y/DA—7290) **Development of the "bandwrap" flywheel.** Knight, C.E. Jr.; Kelly, J.J.; Huddleston, R.L.; Pollard, R.E. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1977. Contract W-7405-ENG-26. 20p. (CONF-771053—3). Dep. NTIS, PC A02/MF A01.

From Flywheel technology symposium; San Francisco, CA, USA (5 Oct 1977).

A program for development of fiber composite flywheels and associated containment was started in May 1976 at the Oak Ridge Y-12 Plant. The development of the first test flywheel in the program is described. The flywheel design uses a thick rim element and unidirectional fiber composite bands which pass around the rim diameter and across a metal hub fitted to the drive shaft. The individual bands are meshed together at the hub and function similar to spokes on a wheel. The design is called the "Bandwrap" flywheel. The development leading to the first test flywheel is reported in the May to September 1976 Project Report. In the development process, conceptual designs were selected for detailed study. After detailed study, the Bandwrap design was selected for fabrication and test. After fabrication, the flywheel was spun to 18,000 rpm where a predicted delamination occurred in the rim. At this speed, the energy stored was 0.25 kwh and the energy density was 10.1 Wh/lb.

12500 (Y/DA—7292) **Analysis of the Deltawrap flywheel design.** Knight, C.E. Jr. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1977. Contract W-7405-ENG-26. 9p. (CONF-771053—6). Dep. NTIS, PC A02/MF A01.

From Flywheel technology symposium; San Francisco, CA, USA (5 Oct 1977).

The higher shape efficiency of the isotropic constant stress disc profile is brought about by the transfer of body force loading in the outermost portions of the disc back to the disc hub region. This is difficult to accomplish with a fiber composite disc because of its low transverse strength. However, the same end might be accomplished in a rim type flywheel design through use of a full overwrap around the rim, tying back to the hub. This is an extension of the "Bandwrap" design but involves considerably more analysis complexities. A model and computer program developed at the Oak Ridge Y-12 Plant calculates the thickness and elastic properties versus position on the overwrap. The thickness is calculated based on coverage per band, number of bands, and band thickness at a given radial coordinate. The elastic properties are derived assuming the overwrap material to be modeled by the properties of an angle ply laminate. The thickness and properties provide input to a finite element model. A linear, elastic finite element analysis provides an estimate of the energy storage potential for this design. The model was two-dimensionally axisymmetric and was analyzed using the ADINA finite element program.

12501 **Flywheels for energy storage.** Vau, G. *PPI;* No. 3, 56(1975). (In German).

A brief survey is presented of the possibilities to use flywheels for meeting peak loads in interconnected operations. The advantages of energy storage with flywheels are immediate availability of the stored energy; site independence; limited space requirements; and no harm to the environment.

THERMAL

REFER ALSO TO CITATION(S) 12550, 12719, 12732

12502 (CONF-770955—2) **Thermophysical properties and behavioral characteristics of phase-change materials.** Cantor, S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

The primary and near-term objective of the project is to compile a handbook of compounds and mixtures that melt in the range of 90 to 250°C and which are suitable for isothermal heat storage. Organic compounds have been screened according to bulk price, thermal stability, and safety. Compounds were selected for further consideration if they cost less than $1.10/kg and if encyclopedia articles or handbooks indicated that they were reasonably stable chemically and were not toxic or otherwise hazardous. Of seven compounds thus selected, four (urea, phthalimide, adipic acid, phthalic anhydride) have been examined by DSC and other methods. The differential scanning calorimeter was used with two fairly well-characterized PCM's to test its applicability for rapidly evaluating thermal decomposition and supercooling. With $Na_2SO_4 \cdot 10H_2O$, DSC data indicated (a) decrease in heat of transition with thermal cycling, and (b) considerable supercooling; with 3 to 6 percent borax added, supercooling was greatly lessened but not entirely eliminated. Measurements with paraffin wax showed that this material does not supercool nor does it degrade in thermal performance with cycling. The DSC results with these two materials confirmed (and extended) thermal performance characteristics obtained by other means. However, studies of supercooling in urea and in phthalimide suggested that DSC techniques may magnify the extent of supercooling at elevated temperatures.

12503 **Steam-proof and water damming, floating covering for the water surface of large heat storage units.** Schoell, G. German(FRG) Patent 2,527,250/A/. 30 Dec 1976. 13p. (In German).

A steam-proof and heat-insulating floating covering for the water surface of large heat storage units is described. The covering consists of several air- and water-tight hose elements which are sealed on both sides. Each hose element is filled with a heat-insulating packing material which has a specific density smaller than water. Each hose element is, in addition, equipped with a valve enabling air passage. The individual hose elements are formed in such a way that each neighboring element grips tightly into its counter-part pairwise. A method for mounting the hose elements is also given.

12504 **Time control part for automatic day and night charge control of electro storage heating devices.** Baeuml, W.; Knoettner, A. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,605,397/A/. 23 Dec 1976. 5p. (In German).

A time-control part for automatic day and night charging control for electro-storage heating equipment is described. The control takes place by means of a potentiometer having a constant current. According to the invention, a time-dependent voltage is produced, which is responsible for shifting the beginning time for charging during the night-low-tariff period. Daytime charging is also made possible by this device, which takes into consideration the necessary heat needs of any particular given day.

12505 **Heat engine operated with liquids.** Cavallo, E. German(FRG) Patent 2,624,767/A/. 16 Dec 1976. 9p. (In German).

A process is described for operating a heat engine with a liquid which is characterised by the fact that a thermal store is used for solar energy, in which the liquid is heated. The storage of solar energy takes place in materials such as stone, graphite, metals, liquids. The materials are blackened for good heat absorption and are thermally insulated against the environment. Heat is taken from the store by liquids, which circulate in pipelines laid in the heat store.

12506 **Process for heat storage.** Zimmer, E. German(FRG) Patent 2,455,561/A/. 26 May 1976. 7p. (In German).

The invention concerns an improvement of the process described in patent specification No 24 00 460, in which a network of channels is arranged in the ground through which water is caused to flow, in order to transmit heat to the earth or to extract it. According to this process the water never leaves the pipes laid in the ground. The improvement according to the invention concerns the case where one is dealing with ground which has good water conducting porous layers. Then hot water from the power station is caused to flow in pipes vertically into the ground, is allowed to enter porous layers through openings in the tube walls, and is sucked upwards by other pipes and thus returned to the power station. To take up heat the process runs in the reverse direction.

12507 **Process for storing heat and heat storage for carrying out this process.** Schioeler, H.; Jensen, J.T. (to Brueel, Schioeler and Tejlgaard A/S, Jystrup (Denmark)). German(FRG) Patent 2,550,863/A/. 20 May 1976. 19p. (In German).

A process is described for storing heat in a heat storage medium such as, for example, damp soil, transmitted by a fluid heat transfer medium such as, for example, water. According to the invention, a temperature gradient is produced in the storage medium from a central zone outwards. For this purpose, the heat transfer medium is taken in the direction of the required temperature gradient to the storage medium when introducing heat, and in the direction opposite to the temperature gradient when removing heat, through an area of the heat storage medium. If in one position of the store the temperature difference between heat transfer medium and storage material is very small or zero, the route through it is shortened, so that no heat transfer material flows through it. A number of straight heat transfer pipes are arranged according to a certain pattern in the heat storage material, e.g. the soil. The incoming and outgoing pipes are coupled up so that a pipe at one end of the route through the store is situated in the middle while a pipe at the other end of the route is situated at the edge of the pipe arrangement.

BATTERIES

12508 Galvanic cell with rechargeable zinc electrodes. von Benda, K. (to Deutsche Automobilgesellschaft m.b.H., Hannover (Germany, F.R.)). German(FRG) Patent 2,364,203/C/. 9 Dec 1976. 1p. (In German).

This additional patent to patent No 2232055 concerns a galvanic cell with rechargeable zinc electrode and claims auxiliary equipment which is arranged between all electrode surfaces of opposite polarity and insulated from the electrodes, with a pore diameter of 0.05 to 1.0 mm. Furthermore, a pore width of between 0.1 and 0.25 mm for fine zinc separation and of between 0.25 and 0.5 mm for coarse zinc separation is claimed.

DESIGN AND DEVELOPMENT

12509 Lithium-iodine cell. Mead, R.T.; Frenz, N.W.; Rudolph, F.W. (to Greatbatch (Wilson) Ltd., Clarence, N.Y. (USA)). German(FRG) Patent 2,616,841/A/. 10 Feb 1977. 31p. (In German).

The patent claims a) the construction and material of a lithium-iodine cell suitable for use in pacemakers, especially the way of its setting and form and arrangement of the modules; b) steps of the procedure to enclose the lithium-iodine cell. The material of the cathode has a charge-transfer complex consisting of an organic donor component and iodine.

12510 Lithium-iodine cell. Mead, R.T.; Franz, N.W. (to Greatbatch (Wilson) Ltd., Clarence, N.Y. (USA)). German(FRG) Patent 2,626,913/A/. 10 Feb 1977. 43p. (In German).

The invention refers to a lithium-iodine cell which can be used for operating pacemakers. The cell's cathodes contain a charge-transfer complex of an organic donor component and iodine. The claim covers design and arrangement of the modules and the way of producing the primary battery. Detailed dimensional data are given.

12511 Electrochemical cell. Momyer, W.R. (to Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA)). German(FRG) Patent 2,621,931/A/. 9 Dec 1976. 17p. (In German).

US-PS 3791871 has as its object a primary battery, which consists of a lithium soluble anode and a hydrogen separation cathode, and can only be made to operate by filling with water. According to this patent specification the current density of the abovementioned cell is considerably increased by mixing hydrogen peroxide or peroxides of alkali metals with the water. The cathode now works as a hydrogen peroxide reduction electrode at a theoretical positive potential of 1.71 V. Hydrogen is no longer released at the corresponding cell loading. The use of soluble sodium peroxide, lithium peroxide and calcium peroxide is claimed.

12512 Galvanic lithium-iodine cell and fabrication method. Schneider, A.A. (to Catalyst Research Corp., Baltimore, Md. (USA)). German(FRG) Patent 2,615,73/A/. 7 Oct 1976. 27p. (In German).

The invention refers to a galvanic lithium-iodine cell with a lithium covering which forms the anode. The cathode is placed inside this anode and consists mainly of an organic complex connection conducting electrical loads and of iodine. Furthermore, the invention refers to a production method for such a galvanic cell.

12513 Sodium-sulphur battery, especially for electric-powered vehicles. Desplanches, G.; Lanzennec, Y.; Wicker, A. (to Compagnie Generale d'Electricite (CGE), 75 - Paris (France)). German(FRG) Patent 2,610,222/A/. 7 Oct 1976. 15p. (In German).

The claims of this patent specification relate to parallel and series circuits of individual cells and modules, to the configuration of heat-insulating containers, to the materials and the manufacturing processes of the container for the positive and negative electrodes, to the materials of the electrical connections and finally to the vehicle having one of the batteries described in this patent specification.

12514 Solid-electrolyte battery, especially for the storage of electricity. Rohr, F.J. (to Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). German(FRG) Patent 2,513,649/A/. 30 Sep 1976. 31p. (In German).

The invention is based on the problem of producing the construction of a solid-electrolyte secondary battery so that a high energy density is combined with high current density and long life. This problem is solved, according to the invention, by making the solid electrolyte battery of a large number of channel-shaped anode and cathode spaces connected in parallel, which are limited by solid electrolyte and are arranged alternately, so that each of the electrode spaces has at least two adjacent electrode spaces of the opposite polarity. A table shows the sodium/sulfur battery as an example of the technical advance achieved by this invention. 22 supporting claims specify the construction details according to the invention.

12515 Lithium-iodine cell. Mead, R.T.; Rudolph, F.W.; Frenz, N.W.; Greatbatch, W.C. (to Greatbatch (Wilson) Ltd., Clarence, N.Y. (USA)). German(FRG) Patent 2,608,443/A/. 23 Sep 1976. 35p. (In German).

The patent claims design and arrangement of modules of a lithium-iodine cell with can be used for operating pacemakers. The cathode of the cell contains a charge-transfer complex consisting of an organic donor component and iodine, its anode is covered with an electro-donor material.

12516 Galvanic energy conversion device with an ionically conducting solid electrolyte. Minck, R.W.; Tischer, R.F. (to Ford-Werke A.G., Koeln (Germany, F.R.)). German(FRG) Patent 2,207,129/C/. 12 Aug 1976. 9p. (In German).

The invention concerns a sodium sulfur battery with sodium ion-conducting solid electrolyte and positive electrodes, which consist of a fibrous electronically conducting layer, in which the electrochemical conversion of the positive electrode takes place, and a metallic contact layer, which is wound on the negative electrode. A metal sheet is used as metallic contact layer, which by being perforated (holes > 1 mm) and being placed at a sufficient distance from the battery case, makes the ingress of participants of the reaction and the egress of reaction products possible.

12517 Energy conversion device with improved electrode shapes. Ludwig, F.A.; Minck, R.W.; Weiner, S.A. (to Ford-Werke A.G., Koeln (Germany, F.R.)). German(FRG) Patent 2,603,404/A/. 5 Aug 1976. 39p. (In German).

The invention concerns a sodium sulphur battery with sodium ion-conducting solid electrolyte and positive electrodes, which consist of a porous metallic conductor and are filled on the inside with molten electrolyte. The object of the claim is the configuration or shaping of the porous metallic conducting layer of the positive electrode made in such a way that channels and/or hollows are formed, which favour the free flow of participatory materials in the reaction and of reaction products of the positive electrode during battery operation.

12518 Design of a lithium/sulfur battery for load leveling on utility networks. Ivins, R.O.; Chilenskas, A.A.; Kolba, V.M.; Towle, W.L.; Nelson, P.A. (Argonne National Lab., IL). pp vp of In Conference on electricity and expanding technology. New York; Institute of Electrical and Electronics Engineers (1975).

From Conference on electricity and expanding technology; Charlotte, NC, USA (6 Apr 1975).

The battery design provides storage of 10 MWh with a 7 h charge and 10 h discharge, as specified for the BEST facility. The cell design and cost estimates assumed the use of FeS electrodes and iron current collectors. Hermetically sealed, multiple-parallel-plate submodules capable of 1000-A discharges were designed. Arrays of these submodules are arranged in series to provide a nominal 1000-V battery system. Performance characteristics based on actual cell data were calculated for an air-cooled battery system. Engineering calculations included cell and submodule temperature distributions. Heat transfer and power requirements were also determied to size ducts and blower. Process flowsheets as well as plant and equipment layouts were developed, and equipment sizes and manpower levels were determined as a basis for estimating manufacturing costs.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 12536

12519 Sealed lead-acid storage battery. Shiomi, E.; Sasaki, S. (Nippon Telegr and Teleph Public Corp, Eng Bur, Tokyo, Jpn). *Jpn. Telecommun. Rev.;* **19**: No. 1, 63-67(Jan 1977).

Commercial tests on sealed lead—acid batteries, using the catalyst method, were carried out in Japan. The catalyst makes it possible to recombine hydrogen and oxygen gas generated from a battery and reduce the gases to water. The battery can be sealed merely by replacing explosion-proof vent plugs with catalyst plugs.

12520 Sealed nickel-cadmium accumulators. Saunders, V. (Varta). *Electron. Eng.;* **49**: No. 591, 61-63(1977).

Features and advantages of the Ni-Cd battery are discussed. The author points out that the popularity of this battery is due to its higher power performance over a wide temperature range, rapid recharge ability, excellent cycle life and the ability to be stored for indefinite periods in any state of charge. These factors are considered.

12521 Lead-acid batteries without maintenance. Dailbard, G.; Atkins, J.; Pothet, J.; Viaud, N. (Cie Eur d'Accumulateurs, Fr). *Rev. Gen. Electr.;* **84**: No. 6, 463-472(Jun 1975). (In French).

The various aspects of maintenance-free lead-acid batteries are described: self-discharge, water consumption, gas tightness. For the positive electrode, after having specified active material composition, the authors study the influence of the proportion of lead dioxide present on the kinetics of self-discharge, as well as the degradation of the active material-grid contact as a function of the alloy used. They show that the self-discharge kinetics of the negative

electrode is closely linked to that of the positive by the oxygen liberated and, for certain alloys, the presence of antimony ions. Water consumption can be reduced by increasing the hydrogen overvoltage, which leads to the use of special alloys with little or no antimony. It is possible, using an appropriate separator, to facilitate oxygen transfer to the negative and thus its reduction. The efficiency can be made 100% by increasing the cell internal pressure and using a limited quantity of electrolyte. Finally, the recombination of hydrogen and oxygen by catalysis is also mentioned.

12522 Reliability of nickel-cadmium cells. Putois, F. (Soc des Accumulateurs Fixes et de Traction, Fr). *Rev. Gen. Electr.;* **84**: No. 6, 473-480(Jun 1975). (In French).

This paper concerns sealed Ni-Cd cells' reliability. It gives for more important applications a qualitative analysis of reliability and explains the failure modes and mechanisms of such generators; an evaluation of reliability parameters is also given. The failure rates obtained $10^{-7}/10^{-8}$ failure per operating hour, are comparable to those of other electronics components. The service life announced is 5 to 10 years at +25°C, corresponding also to life expectancy of numerous electronics systems. Short-circuit is the main failure mode, and the assembly technology of VB button type with stacked plates gives better reliability than VR technology with wound plates.

MATERIALS, COMPONENTS, AND AUXILIARIES

12523 Method and apparatus for charging batteries using variable capacitors. Wahlstrom, S.E. US Patent 4,054,826. 18 Oct 1977. Filed date 4 Dec 1975. 16p.

Method and apparatus for charging a battery or other electrical energy storage means by converting random mechanical motion into electrical energy by utilizing gravitational and acceleration forces are disclosed. The apparatus includes two variable capacitors and a bias supply connected to the battery or electrical energy storage means. The variable capacitors have their capacitance varied in an alternating manner by the physical displacement of a conductive member that forms one plate in each of the capacitors. The moving conductive member causes the electrical charge on the capacitors to be passed back and forth. The apparatus further includes a plurality of diodes located in the circuit so that each time the electrical charge passes between the capacitors the current formed thereby passes through the battery and charges it. 12 figures.

12524 Behavior of magnesium electrodes in alkaline electrolytes. Pelz, R.; Glaeser, W.; Wiesener, K. (Tech Univ, Dresden, E Ger). *J. Power Sources;* **1**: No. 3, 221-236(Apr 1977). (In German with English summary).

The behavior of magnesium electrodes in aqueous alkaline electrolytes was studied. Generally, reproducible current density/overvoltage curves cannot be obtained with such a system, since changes of structural parameters of the electrode take place in the course of time. The transition from the passive state to the active one is particularly important here, but it can also happen that the structural parameters of the passive layers themselves alter. By employing different methods of measurement an attempt was made to obtain a picture of the behavior of the electrode. It was concluded that in systems with activating anions, an elimination of the H_2 is almost impossible during the active stage.

12525 Electrochemical properties of active carbon in acid and alkaline electrolytes. Zoltowski, P. (Inst of Phys Chem of Pol Acad of Sci, Warsaw). *J. Power Sources;* **1**: No. 3, 285-298(Apr 1977).

A comparative study of active carbon in 1 N H$sub $2SO_4$ and in 1 N KOH using chronovoltammetry and cyclic chronopotentiometry has been carried out. The purpose of this study was to find out whether chronovoltammetric curves of active carbon in acid electrolytes are similar to the corresponding curves of other forms of carbon; such simularity would indicate that the redox surface groups hypothesis is valid also in the case of active carbon. Another aim was the interpretation of chronovoltammetric curves of active carbon in alkaline electrolytes.

12526 Galvanic sodium-sulfur battery cell. Evans, L.S.; Markin, T.L.; Bones, R.J. (to Secretary of State for Industry, London (UK)). German(FRG) Patent 2,627,196/A/. 20 Jan 1977. 11p. (In German).

The carbon rod acting as electron conductor at the positive electrode is made in conical shape according to the invention of this patent, in order to obtain a constant current density across its cross-section. Furthermore the carbon rod has a hollow space on the inside, to accommodate electro-chemical reaction products.

12527 Electrochemical element. Rao, B.M.L. (to Exxon Research and Engineering Co., Linden, N.J. (USA)). German(FRG) Patent 2,628,752/A/. 20 Jan 1977. 17p. (In German).

The object of the invention is a lithium sulphur secondary battery which can be operated in the temperature range below 150°C. The following claims are made: 1) Negative electrodes made of 63 to 92% lithium and the rest aluminium. 2) Positive electrodes whose electro-chemically active materials consist of titanium disulphide or transition metals chalcogenides. 3) Non-aqueous electrolyte consisting of dioxalan or of mixtures of lithium perchlorate with dioxalan or other organic solvents, which are inert with regard to the electrode materials.

12528 Electrochemical generator on a sulfur—sodium basis. Desplanches, G.; Lazennec, Y.; Wicker, A. (to Compagnie Generale d'Electricite (CGE), 75 - Paris (France)). German(FRG) Patent 2,617,200/A/. 4 Nov 1976. 13p. (In German).

The subject of the invention is a sodium-sulfur battery with hollow cylindrical solid electrolytes, closed at the bottom and made of beta-aluminium oxide. The sodium functioning as negative electrode is internally inserted. According to the invention, the external side of the solid electrolyte tube is, with the exception of its lower end for the purpose of insulating the graphite felt disk of the positive electrode from the electrolyte tube, surrounded by a porous and electrically insulating coating made of glass fabrics or of ceramic felt made of aluminium oxide or zirconium oxide in order to eliminate the conduction of electrons within the electrolyte, often observed until now, and to eliminate the settling of sulfur on the sodium containing beta aluminium oxide resulting from the disintegration of polysulfides, often occuring during battery charging, as well as in order to increase the number of charge-discharge cycles. Furthermore, a component made of graphite felt disk is placed between the lower end of the electrolyte tube and the bottom of the casing containing the positive electrode. It is an integral part of the positive electrode.

12529 Switching arrangement for the control of the supply voltage of battery-driven equipment. Fritzsche, D. (to Stenocord Electronic G.m.b.H., Muenchen (Germany, F.R.)). German(FRG) Patent 2,517,138/A/. 21 Oct 1976. 7p. (In German).

In order to determine the load of a battery, a Schmitt trigger controlled by an RC member is used which initiates an indicator when the threshold voltage is not longer exceeded. A diode serves as indicating element. The diode lights up for a moment according to the circuit selected after switching on, then it goes out again. The duration of the lighting up helps to determine the state of the battery. In case the battery voltage is reduced, the diode lights up permanently. The circuit described has no additional power consumption during operation under normal circumstances.

12530 Equipment for the catalytic recombination to water of hydrogen and oxygen gases produced during the operation of electric accumulators. Sassmannshausen, G.; Lahme, N. (to Accumulatorenwerk Hoppecke Carl Zoellner und Sohn (Germany, F.R.)). German(FRG) Patent 2,008,218/C/. 30 Sep 1976. 4p. (In German).

A porous catalyst container is arranged in a gas-tight casing connected to the gas space of the battery and, according to the invention, is attached to a body leading outside having a higher gas-flow resistance than the catalyst container.

12531 Charging set for batteries. Esch, U. (to Nife Stahlakkumulatoren G.m.b.H., Berlin (Germany, F.R.)). German(FRG) Patent 2,438,917/A/. 26 Feb 1976. 12p. (In German).

In a charging set a switch causes switching on of the charging current below a first battery voltage, and switching off above a second battery voltage. A time switch ensures the charging of the battery a certain time after the operation of the switching-off switch. The timer only starts to run if the switch was switched on for a certain pre-determined period. In this way, overcharging of the battery can be avoided with certainty.

12532 Connection arrangement for deep-discharging protection of electric accumulators. Rohrbeck, H. (to CEAG Licht- und Stromversorgungstechnik G.m.b.H., Soest (Germany, F.R.)). German(FRG) Patent 2,438,149/A/. 19 Feb 1976. 19p. (In German).

In order to make possible a nearly full utilization of the discharging capacity of electric batteries for emergency power supplies and at the same time to avoid excessive discharge, a change-over arrangement is provided, which contains a fixed lower threshold value and an adjustable upper threshold value. On failure of the supply, after the battery has been discharged to a lower threshold value, the upper threshold value is raised in order to prevent oscillation between switching on and switching off conditions on recovery of the battery; this arrangement makes deep discharge possible.

12533 Charging equipment for accumulators. Balassa, G.; Lindner, K. (to Bosch (R.) G.m.b.H., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,434,350/A/. 29 Jan 1976. 25p. (In German).

Apart from a control circuit for the charging condition of the battery, this charging equipment has a circuit which takes into account the voltage drop between the terminals and battery connections, which is suitable for charging maintenance free cells.

12534 Arrangement for a power supply to electricity loads from a battery. Tillmann, U. (to Elektrotechnik Ehmann G.m.b.H., Hoechstberg (Germany, F.R.)). German(FRG) Patent 2,433,356/A/. 22 Jan 1976. 8p. (In German).

A semi-conductor circuit ensures in vehicle power supplies with various additional loads that the additional loads are switched off at the battery before this is discharged to such an extent that for example, starting of the vehicle engine is no longer possible. A semiconductor circuit monitors the cell voltage and trips a load if the voltage at the battery falls below a certain value, and blocks repeated switching on.

12535 Device for level indicating. Sutcliffe, H. (to Salford Univ. (UK)). German(FRG) Patent 2,530,414/A/. 22 Jan 1976. 13p. (In German).

An electromagnetic AC field is induced in the surface area of an electrically conducting liquid for level indication in the liquid. The indication of energy loss is a measure of liquid level. To compensate for values which are of no interest for the measurement, such as temperature and conductivity, a submerged second coil is provided. Application is for the indication of level of electrolyte in an electrical battery.

12536 Asymmetric ac charging increases battery life. Rohlander, W. *Elektron Int.;* No. 2, 43(1976). (In German).

A brief description is given of the known method of charging a battery from ac via a half-wave rectifier shunted by a resistor that allows roughly 10 percent of the battery's dc voltage to flow during the rectifier's reverse-biased condition. This circuit causes the metal ions of the battery to be deposited back onto the plates more evenly than would be the case with pure dc (where clumping results in reduced lifetime). Higher charging currents can also be used because of the lower internal resistance.

12537 Cell with a stepwise variable output voltage. Angelovich, S.J.; Fagan, F.G. Jr. (to Mallory (P.R.) and Co., Inc., Indianapolis, Ind. (USA)). German(FRG) Patent 2,514,795/A/. 23 Oct 1975. 17p. (In German).

The positive electrode of a secondary cell or the cathode of a primary cell, according to the invention, obtains two or more electrochemically active materials with discharge potential, which have small but distinct differences. The lowest step of the stepwise discharge curve can be used for the production of an alarm signal. This invention is preferably used in primary batteries with cathodes which contain cadmium oxide and mercury oxide as active materials.

12538 Buffer accumulator charger. Mamon, M. *Electron. Microelectron. Ind.;* No. 209, 46-47(1 Oct 1975). (In French).

The charger described, for a 120-Ah accumulator, minimum voltage 22, maximum voltage 28, regulated voltage 24, has an output current which can be present up to 40 A and is supplied from a 220-V, 45- to 65-Hz mains supply.

12539 Secondary battery and its cathode. Gay, E.C.; Martino, F.J. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,501,881/A/. 7 Aug 1975. 27p. (In German).

The patent specification relates to a lithium/sulfur secondary battery and gives details of the model design regarding the charge-discharge voltages, capacities and current densities, the charge-discharge efficiencies and the chemical composition and preparation of the positive electrode. According to the invention the positive electrode contains a transition metal sulfide and a sulfide reaction product of the alkali metal of the electrolyte or of the negative electrode and the transition metal sulfide. The whole atomic concentration of the sulfur is present inside the positive electrode as a sulfide in a stoichiometric excess of the whole atomic concentration of the transition metal.

12540 Battery cell with a positive active mass of silver chromate. Gerbier, G.; Rivault, J.P. (to Societe des Accumulateurs Fixes et de Traction, 93 - Romainville (France)). German(FRG) Patent 2,450,923/A/. 30 Apr 1975. 7p. (In German).

Galvanic cells with lithium as the negative active mass, an electrolyte consisting of a solution of lithium perchlorate in propylene carbonate, and silver chromate as the positive active mass can be stored for longer periods at increased temperature (e.g. 90°C), and they can be discharged without substantial capacity losses, if the positive mass, according to the invention, contains between 5 and 30% per weight (preferably 12) powdered silver.

APPLICATIONS

REFER ALSO TO CITATION(S) 12798, 12799, 12800

ENERGY MANAGEMENT AND POLICY

12541 From bench to busbar. *EPRI J.;* **2**: No. 8, 18-19(Oct 1977).

The aspects of successful commercialization of a new product or process are discussed. The simultaneous presence of five elements is needed: (1) research and development must be continued until all principal technical problems are solved; (2) there must be a customer in need of the product; (3) an advocate for new technology must be visible and actively committed to ensuring commercialization; (4) money, manpower, and fuels must be available; and (5) risk factors (economic, political, and social) must be favorable to encourage private sector investment. A case study of a high-intensity ionizer is offered to illustrate how EPRI has caused the convergence of the five elements favorable to technology transfer. (MCW)

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 12549, 12552, 12587, 12589, 12636, 12648, 12738

12542 (ORAU/IEA(R)—77-12) **Net energy analysis of five energy systems.** Perry, A.M.; Devine, W.D. Jr.; Cameron, A.E.; Marland, G.; Plaza, H.; Reister, D.B.; Treat, N.L.; Whittle, C.E. (Oak Ridge Associated Universities, Inc., Tenn. (USA)). Sep 1977. Contract EY-76-C-05-0333. 156p. Dep. NTIS, PC A08/MF A01.

A net-energy analysis is performed for each of five developing energy technologies: ocean thermal energy conversion, wind energy conversion, in-situ oil shale processing, fluidized-bed coal combustion, and municipal solid-waste utilization. Energy expenditures required during construction and life-long operation and maintenance are estimated using input-output and process analyses. These expenditures, including both direct and indirect consumption, are classified as capital or operating expenditures and as expenditures for electric or nonelectric inputs to the systems. Various ratios that compare the anticipated energy product of a system to its estimated energy subsidy are defined. It is not, in general, possible to compare dissimilar technologies on the basis of these performance indices. However, the indices do indicate all of the systems considered here are net producers of energy and decisions to proceed with development and deployment should be based on other considerations.

12543 Closing the circuit between modelers and decision makers. Greenberger, M. (Electric Power Research Inst., Palo Alto, CA). *EPRI J.;* **2**: No. 8, 6-13(Oct 1977).

Energy has two sides: (1) the varied effects emanating from the use of energy, and (2) the span of technologies, fuels, and other resources entering into the supply, conversion, distribution, and consumption of energy. Energy decision makers sit between these two sides; they need a means for integrating the dissimilar results on each side. A more effective communication and improved understanding between energy researchers and energy decision makers are needed. In light of this, the Systems Program at EPRI is experimenting with a number of ways to bring the information obtained from modeling to decision makers. Its transfer project and its Energy Modeling Forum project are discussed. Twenty-four models that are available are listed, with a brief statement of the use of each; the ones used in the first study of EPRI's Energy Modeling Forum project are indicated. (MCW)

12544 Nested decomposition of a dynamic energy model. Ho, J.K. (Brookhaven Natl Lab, Upton, NY). *Manage. Sci.;* **23**: No. 9, 1022-1026(May 1977).

This paper reports computational experience in using a nested decomposition (staircase) algorithm to solve a version of Manne's linear programming model of U.S. energy options. Nested decomposition is found to be 28% to 52% faster than a direct simplex approach for the test problems. Effects of various computational strategies are also investigated. Results indicate the applicability of nested decomposition to the important class of staircase linear programs arising from dynamic energy models. 4 refs.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 12055, 12558, 12560, 12561, 12564, 12571, 12580, 12585, 12602, 12612, 12630, 12631, 12641, 12733

12545 (COO/4128—1, pp 101-123) **Factors affecting the rate of adoption of a new technical innovation: a literature review.** Fishelson, G.; Townsend, S. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

A model explaining the rate at which a new storage device will be adopted and the extent of that adoption is presented. It focuses on this specific innovation and its effect on industrial growth and on the purchasing and utilizing sectors, i.e., rate of market penetration and adoption. The industrial market penetration and the consumer adoption models are kept separated. Section II presents a simple model of the adoption process abstracted from more general models developed elsewhere. Section III reviews some of the eco-

nomic literature on the diffusion of new innovations, processes, and products. Conclusions are summarized in Section IV. 41 references. (MCW)

12546 (COO/4128—1, pp 124-235) **Market penetration by new innovations: the technological literature.** Hurter, A.P.; Rubenstein, A.H.; Garvey, J.; Martinich, J.; Bergman, M. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

The methodology for dealing with market penetration by new innovations is reviewed in Part I, utilizing 126 references. Part II discusses the management, engineering, and other non-economic literature that deals with the introduction of new technologies into the market. Many examples are given in all sectors in an appendix to Part II. The bibliography to Part II is composed of 31 citations. (MCW)

12547 (COO/4128—1, pp 236-252) **Market penetration: the demand for energy storage capacity—an energy substitution model.** Fishelson, G. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

One possible approach for determining the market penetration of energy storage devices has been presented previously. Another possible approach would be to try to gauge the rate of penetration using the short-run elasticities of demand for appliances, durable goods, and the fuels and energy sources. However, the nature of the demand for energy-storage devices suggests that the second approach might be misleading. The reason is that the storage device is a substitute for other means through which the demanded energy at a specific time can be obtained. Thus, an estimate of the elasticity of substitution between various energy sources is needed. The empirical results presented in this paper contain estimates of the elasticities of substitution among energy sources for three particular years within a period of 15 years. The 3 years are 1957, 1958, and 1962. The lack of data prohibits similar estimations for more recent years. The following section discusses the model and the data. It is followed by the results and a discussion of them.

12548 (COO/4128—1, pp 253-284) **Empirical estimations of the rate of commercialization of energy sources and fuel uses.** Fishelson, G. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

An empirical analysis is reported that is a first-stage investigation into the evolution of the market structure of energy over time. The empirical analysis contains two major parts — an analysis of the energy market by sector over time and an energy-appliance analysis for the household sector. It is a cross-section analysis. (MCW)

12549 (COO/4128—1, pp 285-311) **Econometric model of innovation.** Krumm, R.J. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

A model of the innovation market oriented toward an empirically testable hypothesis is developed. Hence, this paper serves to transform some economic characteristics of the innovation process into a testable format. Specifying the nature of the derived demand curve for a specific innovation and relating this to the observed cost of acquiring and using this new process provides a methodology for analyzing the innovation market. Section II develops a non-stochastic model of the innovation market focusing on how changes in the demand for this innovation across firms affects the decisions to invest and the quantity to invest. Section III extends this analysis in a stochastic framework that is relevant for empirical examination. Section IV presents a Bayesian interpretation to the analysis of the stochastic model with additional empirical applications. Section V considers how the models developed in earlier sections may be empirically tested with respect to intra- and inter-firm cross-sectional and time series analysis. Finally, Section VI concludes with some possible extensions.

12550 (COO/4128—1, pp 312-322) **Profitability, uncertainty, and the rate of adoption of innovations.** Wiley, A. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

It is shown that the rate of adoption of thermal energy storage (TES) is a function of both its expected profitability and the uncertainty of returns associated with it. Profitability is shown to be a function of the peak-off peak price differential, the amount of energy used, and the interest rate applied to future savings. Uncertainty has been shown to be dependent on the type of pricing system used, with load-management contracts shown to have the greatest potential for reducing uncertainty. British data were used to estimate the parameters of the logistic function, and the effects of a change in the rate of adoption were estimated.

12551 (COO/4128—1, pp 323-358) **Factors affecting the prices of alternative fuels.** Fishelson, G. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

The paper demonstrates the lack of unanimity on the issue of fuel and energy price projections. This is a direct by-product of two common views of the energy problem. One view is that the world is running out of conventional energy resources and, without a drastic switch to unconventional sources in the near future, the price of energy will sky rocket. The other view is much more moderate; it envisions a positively sloped supply curve of conventional energy sources and relatively high elasticities of substitution between sources, either in the final consumption stage or at a conversion stage. The price of energy would rise also according to the second view but at a lower rate. This rate would be controlled by the economic forces and variables affecting demand and supply. 18 references, 8 footnotes.

12552 **Production inefficiency in the peak-load pricing model.** Berkowitz, M.K. (Univ. of Toronto); Jen, F.C. *South. Econ. J.;* **44**: No. 2, 374-379(Oct 1977).

From Conference on public utilities: economics and finance; Los Angeles, CA ;USA: (16 Aug 1976).

The implications of pricing electricity on the basis of peak-load demand are examined in a model which introduces the factors of scale economies and periods of unequal duration. The author points out that new technologies to replace fossil-fueled steam generation with nuclear, photovoltaic or other energy sources will introduce new opportunities for scale economies. The impact of regulatory bias on peak-load prices indicates that there is benefit only to the peak users unless ex ante substitution allows prices to be reduced for non-peak periods. More capital-intensive techniques are also induced by ex ante substitution. The model examines the effects of a range of regulatory constraints on production efficiency and the capital-labor ratio. 18 references. (DCK)

12553 **Creating jobs in an Indian community.** Smith, J. (Oklahoma State Univ., Stillwater). *Growth and Change;* **8**: No. 4, 33-37(Oct 1977).

The policy of providing full employment opportunities and economic development in Indian communities by using public funds to create jobs in areas of high unemployment was studied for its effectiveness on 21 Indian reservations. The Economic Development Administration has been conducting this type of program since 1967. A discriminant analysis was used to determine which projects succeed or fail because of locational socio-economic variables. Regression analysis was used to identify the socio-economic characteristics that are associated with successful projects. Indian communities vary in the emphasis placed on home, family, and cultural ties and the impact of this emphasis on migration. The study is recommended to policy makers to help them make appropriate allocations of public funds. 14 references. (DCK)

12554 **Perspectives in energy financing.** Ponto, J. (Dresdner Bank A.G., Frankfurt am Main (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 12, 375-378(Jun 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

The author indicates the problems that arise nowadays in financing in the field of energy economics. In this connection he draws attention to the magnitude of the risk incurred in the application of energy in the future, a risk not only for the banker but also for the whole of the political economy.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 11658, 12620

12555 **Floodplain management system model.** Weisz, R.N.; Day, J.C. (Univ. of Arizona, Tucson). *Growth and Change;* **8**: No. 4, 23-27(Oct 1977).

Floodplain management is shifting from Federal emphasis on regulations to engineer streamflow to local land use planning. Difficulties with interagency coordination were studied and a planning methodology that brings together engineering and land use planning has been developed and tested. The study is described as a floodplain management system (FMS) whose objective is to maximize aggregate economic rent. The model sets planning constraints, including noneconomic considerations, to determine the combination of development policies, land use regulations, and engineering options that will be the most economically efficient. Results will vary according to specific local characteristics. 21 references. (DCK)

12556 **NO/sub x/ emission trends and Federal regulation.** McCutchen, G.D. (EPA, Research Triangle Park, NC). *Chem. Eng. Prog.;* **73**: No. 8, 58-63(Aug 1977).

This paper reviews existing trends in the emission level of nitrogen oxides from stationary source and critically analyzes existing and proposed regulatory measures in the subject. It is demon-

strated that a multi-pronged regulatory strategy is needed to reverse a projected 66% increase in nitrogen oxide emissions from stationary sources. Sources of nitrogen oxides emissions are linked with quantity data at present and in the future (1985). 5 refs.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 11702, 12580

12557 (NP—22719) **Water for western energy development update 1977.** (Western States Water Council, Salt Lake City, Utah (USA)). Sep 1977. 35p. States Water Council, Salt Lake City, UT.

This report contains projections of steam-electric plants and other energy production developments in the west to 1990 and presents findings in regard to their estimated water requirements. Important institutional considerations and water conservation opportunities relating to western energy development also are examined. National load growth is expected to be between 3 and 5% per year and is expected to reach a total demand of 170 quads by the year 2000. Western energy consumption will total about 25 quads over the same period, about half of which will be electrical energy. By 1990, oil-shale processing may be barely started, geothermal development will be small, and only two coal gasification facilities are planned. Five coal slurry pipelines are planned with a total water requirement of 46,000 AcFt/yr to transport 59 million tons per year. Firm plans exist among Western utilities to construct 85 additional large steam-electric generating units in 46 locations, with an aggregate capacity of 46,189 MW. Total water requirements for the various technologies are reviewed and the impact of energy conservation measures is forecast. (MCW)

12558 **Factor costs and factor use: an analysis of labor, capital, and natural resource inputs.** Moroney, J.R. (Tulane Univ., New Orleans); Toevs, A.L. *South. Econ. J.;* **44**: No. 2, 222-239(Oct 1977).

Input models are used to project the impact of resource depletion to determine how the effects of scarce input can be lessened and how dependence on resources can be alleviated. A model was used to test substitutions in the labor, capital, and specific resource inputs with seven U.S. industries, three of which use renewable resources and four use nonrenewable sources. Trends are indicated for resource substitution and capital against labor, which did not occur in the case of petroleum refining. Technology, in the long run, reduced labor inputs, although the process is reversible. The study concludes that (1) substitutions against resource inputs can offset current and anticipated shortages; (2) not enough time has passed to justify calling trends of the 1970s permanent; (3) resource-intensive industries need to make more capital-intensive adjustments than those less directly dependent on resource inputs; and (4) options available to a society to cope with resource depletion have not been fully defined. 4 tables, 45 references, and a data appendix.

12559 **Economic evaluation of small decentralized energy projects.** *URJA;* **1**: No. 6, 25-28(Jun 1977).

In the developing countries of the world, traditional sources of energy have been animal and human effort and crudely utilized forms of animal and vegetable matter. Water and wind power and recently rural electrification schemes have become important. With increased petroleum prices, the development of decentralized technologies to use traditional energy sources has progressed. Biogas, solar energy, wind power, and mini-hydroplants have become alternative new energy sources. Some of the critical factors concerning the economic evaluation of alternative sources are discussed with emphasis on biogas technology. Characteristics and cost benefits are summarized for biogas but may be applied to all alternative energy sources. (MCW)

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 12545, 12546, 12548, 12549, 12609, 12632, 12633

12560 (COO/4128—1) **Methodology of evaluating research and development projects. Final report.** Tolley, G.S. (Chicago Univ., Ill. (USA)). Sep 1977. Contract EY-76-C-02-4128. 445p. Dep. NTIS, PC A19/MF A01.

A separate abstract was prepared for each of the 13 chapters of this document. (MCW)

12561 (COO/4128—1, pp 1-21) **Economic assessment of research and development.** Tolley, G.; Townsend, S. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

Research has provided new processes and ideas that can be utilized in new technologies for the production and conservation of energy; many technologies are not yet profitable. Rising fuel prices, improved efficiencies, and reduced production costs will increase profitability until many of the more exotic technologies will, at some time, become economically feasible. Research and development projects can accelerate this process and can be analyzed as investment activities. After a discussion on the rationale for government support in research, a method is developed for the systematic comparison of energy storage research and development projects that are competing for Federal funding. The government attempts to use criteria in deciding on which project to fund so as to obtain the most return from public investment in energy-conserving technologies. (MCW)

12562 (COO/4128—1, pp 57-67) **Transfer of energy research and development from public to private initiative.** Norgaard, R. (Univ. of California, Berkeley). Sep 1977.

In Methodology of evaluating research and development projects. Final report.

Research and development initiated in the public sector should be transferred to the private sector at the point that results in the greatest net present social value. Some technologies should remain in the public sector longer than others. Applying maximum net present social value criteria to specific cases is a complex matter. This paper explores these complexities and summarizes in mathematical form the simple criteria for deciding when to transfer R and D from public to private initiative. (MCW)

12563 (UCRL—52000-77-6) **Energy and technology review.** Selden, R.W.; Shay, H.D.; Crawford, R.B.; Cummings, K.L.; Staehle, J.T. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract W-7405-ENG-48. 35p. Dep. NTIS, PC A03/MF A01.

Each of the three main sections was processed separately for ERA, EAPA, and the Energy Data Base.

12564 **Energy research: alternative strategies for development of new energy technologies and their implications for the Federal budget.** Washington, DC; Congress of the United States (1976). 83p. (NP—22493). GPO $1.25.

The booklet analyzes and provides background information about Federal efforts in research, development, and demonstration of new and emerging energy technologies. The criteria for designing research strategies may be grouped into three categories: support of desirable futures, insurance against failure, and cost. To illustrate the application of these criteria, five potential alternative research strategies were evaluated. Each strategy differs in the degree to which it satisfies the criteria. The strategies are: (1) a strategy of continuing ERDA's present programs, completing ongoing projects and allowing modest real growth, but not allowing major new starts; this is referred to as the "base program completion" strategy; (2) "full funding" strategy, including the elements of the base program completion strategy and carrying out all major additional R, D, and D projects identified in ERDA's national plan; (3) a strategy emphasizing long-term nuclear fission technologies and downplaying all others; (4) a strategy downplaying the fission programs but emphasizing all other long-term technologies; and (5) a strategy emphasizing nar- and mid-term technologies and deferring all major long-term technology demonstration projects not already underway. (MCW)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 11699, 11703, 11738, 11751, 11771, 11774, 11783, 11785, 12165, 12175, 12216, 12265, 12268, 12274, 12275, 12302, 12304, 12305, 12413, 12426, 12631, 12653, 12656

12565 **Australia unlocks her uranium reserves.** Scott, W.E. *Energy Int.;* **14**: No. 11, 25-27(Nov 1977).

The economic implications of Australia's move to permit the development of uranium mining and to resume exporting uranium have led to forecasts that range from pessimism over unseen factors to an optimistic estimate of $A20 billion and 500,000 jobs. Direct benefits will go to those involved in road construction, mining equipment, and construction camps. The goverment plan calls for mining operations and yellowcake exports from four major uranium mines by 1985. An overview is given of the development plan, which emphasizes an orderly procedure rather than exploitation and excessive competition. The uranium industry is viewed as a stable long-term supplier for international trade. Customers will be required to submit to international Atomic Energy Agency inspection and must guarantee to limit their uranium use to peaceful projects. (DCK)

12566 **Centrifuge plants enter the enrichment market.** Jeffs, E. *Energy Int.;* **14**: No. 11, 28-30(Nov 1977).

The first two commercial-size uranium enrichment centrifuge plants opened in the United Kingdom and the Netherlands at a time when the future of the nuclear industry in both countries and West Germany is open to political question. The program's future was

reinforced, however, when the U.S. announced its enrichment capacity will be based on centrifuge technology. The two new plants represent the successful industrial cooperation of three European nations, each of which has representatives on both Boards of Directors. Performance and design data are given for the plants at Capenhurst, England and Almedo, in the Netherlands. Future plans include expansion of capacity, although the Urenco partners do not intend to use the large programmed centrifuges planned by the Americans. They will use, instead, a cascade arrangement of small centrifuges, each functioning as an independent working unit. (DCK)

12567 Development trends in nuclear energy: impressions from the IAEA international nuclear energy conference in Salzburg. Posner, E. *Glueckauf;* **113**: No. 7, 681-687(Jul 1977). (In German).

Problems of world energy demand, nuclear fuel supply, recycling and disposal, reactor systems, safety, public relations of the industry, and international cooperation raised at the Conference are discussed. 12 refs.

12568 Markovian cross-impact model. Eymard, J. (Paris Airport Auth, Fr). *Futures;* **9**: No. 3, 216-228(Jun 1977).

A cross-impact method is described which is based on Markov-chain theory. This allows scenarios to be derived which explicitly include the time dimensions. An example of the use of the method is included which deals with the installation of nuclear reactors for energy production. 9 refs.

12569 Nuclear power: the achievements, the problems, and the myths. Hill, J. *S. Afr. Mech. Eng.;* **27**: No. 5, 135-143(May 1977).

An important difference between the use of uranium and the use of fossil fuels is that there is the possibility of increasing enormously the heat output obtained from one pound of natural uranium by changes in reactor design. Present designs of commercial reactor only burn about 1% of the input of natural uranium before it is so depleted in fissile material that the remaining 99% has to be rejected as unusable waste. The fast reactor is in principle capable of burning all the uranium, and even allowing for losses it will be possible to get up to a 50-fold increase in uranium utilization. It is able to burn the waste uranium that has been left over from the first generation of reactors. In the United Kingdom alone the amount of waste uranium stored in drums and tanks would, if used in fast reactors, produce as much heat as 50,000 million tons of coal.

12570 Nuclear futures for sale: issues raised by the West German—Brazilian nuclear agreement. Lowrance, W.W. (Harvard Univ., Cambridge, MA). pp 201-221 of In International arrangements for nuclear fuel reprocessing. Chayes, A.; Lewis, W.B. (eds.). Cambridge, MA; Ballinger Publishing Company (1977).

From Symposium on international arrangements for the nuclear fuel cycle; Racine, WI, USA (24 May 1976).

See CONF-7605166—.

When the Brazil-West Germany 15-year Agreement of Cooperation in the Peaceful Use of Nuclear Energy was signed in Bonn on 27 June 1975, the event stirred controversy all over the world. This paper reviews those events, discusses their unfolding and present implications, and draws a moe general description of the political territory. Safeguards in the agreement are described. It is concluded that: many of the German arguments for including the sensitive technologies in the deal are specious; U.S. policies on nuclear exports are incoherent and inadequate; there is now a great burden on Brazil to show its good intentions; the advanced nuclear nations need to make crucial decisions; proposals for multinational fuel facilities need to be evaluated; and proliferation issues should be accorded much higher political attention. (DLC)

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 12547, 12550, 12634, 12719, 13590

12571 (COO/4128—1, pp 359-368) **Private cost of electrical energy from different primary and storage sources.** Townsend, S. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

Framework developed to apply to several energy systems is presented. The data were obtained from Public Service Gas and Electric Company and Argonne National Laboratory. Basic assumptions to calculate capital charge rates are listed and the method to calculate cost per megawatt hour is followed. Input data and results for an annual operation of 250 days and between 2 and 8 hours per day are tabulated for near- and long-term compressed air; fossil steam (near- and long-term); combined cycle (near- and long-term); gas turbines (near- and long-term); regenerative turbine (near- and long-term); hydropumped storage; near-term batteries and thermal storage; long-term hydropumped storage, batteries, thermal, chemical, and flywheel technologies; superconducting magnets; and Argonne pumped hydro and batteries. (MCW)

12572 Kleine Anfrage von Abgeordneten wegen Energiespeicherung. (Question raised in the Bundestag concerning energy storage). Bonn, Germany, F.R.; Bundestag (24 Mar 1977). 20p. (In German).

The storage of energy is an important part of power supplies. Structural changes in the energy economy can more easily be carried out with imporved energy storage technology. New energy sources, for example, solar energy could be better utilized. Therefore, the question 'What are the technical possibilities and prospects for energy storage' is put to the Federal Government.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 12055, 12302, 12757

12573 District heating in Finland. Kilpinen, U. (Helsinki Electricity Works (Finland)). *Fernwaerme Int.;* **6**: No. 4, 183-189(Aug 1977).

In the last ten years district heating, and electricity generation combined with it, has increased five times in Finland. About 17% of all dwellings in the country are now supplied with district heating. New heat-electric stations are now under construction. New housing estates are often supplied provisionally from transportable heating stations until connection is made to the district-heating system. In his article the author also deals with the competitive capability, advertising, and tariffs for district heating. 6 figs., 3 tables, 3 refs.

12574 Investigation into the use of large-scale total-energy systems in mild and warm climates. Reale, F.N.; Dillon, T.S. (Monash Univ, Clayton, Victoria, Aust). *Fuel;* **56**: No. 3, 257-265(Jul 1977).

The viability of total-energy systems in mild and warm climatic conditions is investigated. Under such conditions, to be viable, the main load for the total-energy system must come from industry. An investigation into the types of industries and their low-grade requirements was therefore carried out. It was found that industrial heating loads are such that approximately 35% of the heat energy requirements of a typical industrial mix can be supplied by low-grade heat below 230°C. When supplemented by conventional and domestic requirements, it is shown that total-energy plants fueled by coal with an electrical capacity of about 300 MW are economically viable in mild Mediterranean climates. The paper presents a detailed analysis of capital and operating costs for such a plant over a twenty five-year period. 10 refs.

12575 Fernwaerme. (District heating). Matthoefer, H. (ed.). Frankfurt, Germany, F.R.; Umschau (1977). 118p. (In German).

This pocket edition 'District heating' aims at making widely available the partial results of a study on district heating supply in the FRG instigated by the BMFT (Federal Ministry for Research and Technology). According to the editor this book is to stimulate the discussion on district heating supply and to awaken approval for this type of space heating which is not harmful to the environment and easy on energy. The booklet starts with portraying the energy situation in the FRG, deals with possible utilization of regenerative energy sources, and reflects on the efficient use of energy and on a future district heating concept. The main part is dedicated to district heating supply with heat-power coupling. The last chapter is concerned with small-scale heating and power stations.

12576 Contribution to the solution of problems concerning urban district heating supply. Thalmann, G. (Hamburgische Electricitaets-Werke A.G. (Germany, F.R.)). *Fernwaerme Int.;* **6**: No. 3, F1-F4(1977). (In German).

Using experiments on back-pressure steam turbines and on extraction-condensation steam turbines as examples, the author shows how an electric power loss in heating power operation for nonsteady heat transfer processes (heat transfer from the rooms to be heated to the atmosphere) can be influenced. The results obtained by means of the experiments are used for planning and realizing an example with the aim of finding guiding rules for the planning of supplying cities with district heating. 5 figs, 3 tables, 6 refs.

12577 Integration of the heat-electric economy into the electricity supply economy. Schenk, P. (Stadtwerke Duesseldorf A.G. (Germany, F.R.)). *Fernwaerme Int.;* **6**: No. 3, 58-60(1977). (In German).

From 7. annual meeting and discussion meeting with 2. district heating exhibition of the Arbeitsgemeinschaft Fernwaerme e.V. (AGFW) at the VDEW; Duesseldorf, Germany, F.R. (2 - 4 May 1977).

The German electricity supply industry has so far offered considerable possibilities of development of district-heating supply by means of heat-electric stations, when compared with other supply undertakings (mostly nationalized). For a number of reasons they will increase this trend. Numerous district-heating supply organisations are even today supplied economically by heat-electric stations

near the point of consumption. A further development of the principles and methods adopted in making district-heating available is, in the opinion of the electricity supply industry, desirable from the point of view of energy policy; further it gives advantages to the whole national economy without any adverse effect on the special interests of the electric power economy.

CONSERVATION

REFER ALSO TO CITATION(S) 12592, 12606, 12630, 12649, 12656, 12719

12578 (CONF-770870—2) **Conservation and the contributions from advanced energy sources.** Beall, S.E. Jr. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

From Proceedings of the faculty institute energy conservation) theory and practice; Oak Ridge, TN, USA (1 Aug 1977).

Even if conservation efforts are very effective, this nation cannot be energy self-sufficient by 1985. This paper discusses the advanced energy sources being developed by ERDA, predicts a contribution of 1 Q (quadrillion Btu) or less in 1985, and estimates perhaps optimistically that these new technologies can contribute as much as 25 Q of our energy needs by 2000 A.D.

12579 Energy-saving program for Baden-Wuerttemberg. *Oel;* **15**: No. 7, 184-188(Jul 1977). (In German).

Apart from saving energy, the energy saving program of the Land Government of Baden-Wuerttemberg promotes the speedy removal of other energy sources, which should replace the use of oil, which one cannot manage without nuclear power. The program contains measures which require no financing. It concerns above all the change of existing regulations and recommendations for industrial and private consumers and consultancy for them. Measures are also provided whose realization will require additional domestic expenditure, such as the extension of district heating supplies, the careful use of energy in publicly owned high-rise buildings, the requirement for obtaining hot water using solar collectors, the support of demonstration projects and expert evaluation. 100 million DM are being invested in these projects, including public funds.

12580 Energy and resource conservation. Ratcliffe, B.G. (Loughborough Univ, Engl). *Chart. Mech. Eng.;* **104**: No. 6, 96-102(Jun 1977).

The challenges created for the municipal engineer placed to play a major role through his position in public service responsible for many of the technical and managerial aspects of energy and resource conservation are discussed. 22 refs.

12581 Verordnung der Bundesregierung. Verordnung ueber energiesparende Anforderungen an heiztechnischen Anlagen sowie Brauchwasseranlagen (Heizungsanlagen-Verordnung). (Ordinance of the Federal Government. Ordinance concerning energy-saving requirements to be made on heating appliances and appliances for supplying hot water (Heating Equipment Ordinance)). Bonn, Germany, F.R.; Bundesrat (24 Mar 1977). 20p. (In German).

This order applies to heating appliances, appliances supplying hot water, and equipment with a heat rating of more than 4 kW, which are operated with solid, liquid, or gaseous fuel; by district heating; or via a resistance heater using electricity. The order applies (1) if they are installed in new buildings or for continuous use, or (2) as far as they are installed in existing buildings, for continuous use, or are replaced, enlarged upon, or converted. Exceptions are appliances and equipment in thermal power stations, including peak-load stations and waste heat stations.

12582 Verordnung der Bundesregierung. Verordnung ueber energieeinsparende Anforderungen an den Betrieb von heizungstechnischen Anlagen und Brauchwasseranlagen (Heizungsbetriebs-Verordnung). (Ordinance of the Federal Government. Ordinance concerning energy-saving requirements to be made in the operation of heating appliances and appliances for supplying hot water (Heating Operation Ordinance)). Bonn, German, F.R.; Bundesrat (24 Mar 1977). 22p. (In German).

This order applies for the operation of heating appliances and appliances for supplying hot water and equipment with a heat rating of more than 11 kW, which are installed in buildings or for continuous use and are operated with solid, liquid, or gaseous fuel; by district heating; or via resistance heaters using electricity. Exceptions are appliances and equipment in thermal power statios, including peak-load stations and waste heat stations.

12583 Energy conservation laws and regulations. Casson, J.E. (Arent, Fox, Kintner, Plotkin and Kahn, Washington, DC). pp 123-131 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

President Carter's early statements on energy conservation are related to legislation existing at the start of his administration, and a comprehensive policy of new regulations is predicted. Top priority is expected to be given to conservation, accompanied by appropriate budget adjustments. Summaries of existing legislation cover the Energy Conservation and Policy Act of 1975, which includes state energy planning and voluntary industrial reporting, and the Energy Conservation and Production Act of 1976, which includes efficiency standards for new and existing buildings and provisions to encourage the use of renewable resources. Coal utilization has also been promoted. Recommendations to industrial users on the basis of these policies are to determine how legislation will affect an individual company and actively intervene at appropriate times during policy development. Companies are also urged to conduct energy audits to identify areas of waste that can be remedied in anticipation of new regulations. (DCK)

12584 State energy conservation plan and feasibility report guidelines. Koach, J.L. pp 132-134 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

The National Insulation Contractors Association (NICA) maintains that improved insulation design will permit 1990 conservation goals to be met at a saving of $35 billion to users. Legislation aimed at encouraging the acceptance of industrial insulation ignored the fact that present standards are outdated. NICA proposes an aggressive program of state conservation goals based on the results of one-day information meetings and reference to York's study titled "Economic Thickness for Industrial Insulation". Insulation manufacturers and technicians could participate in the seminars with industrialists. The seminars would allow a consensus on realistic conservation guidelines to evolve. (DCK)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 11703, 12606, 12637, 12647

12585 Trend confirmed: electric power consumption grows with economic growth. *Energie;* **29**: No. 6, 169-172(Jun 1977). (In German).

Business reports of the FRG's leading energy supply enterprises confirm: right across all fields of the energy supply industry, whether electric power, oil or gas, there is evidence of direct relationships between economic growth and higher energy consumption figures. 2 figs, 6 tables.

12586 Energy-supply in the Federal Republic of Germany and Western Europe especially in consideration to the potential of oil and gas in the North Sea. Grathwohl, M. (Fuehrungsakad der Bundeswehr, Hamburg, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 6, 233-238(Jun 1977). (In German with English abstract).

The paper describes the structural development of primary energy consumption in the Federal Republic of Germany and Western Europe until 1990; especially the supply situation in respect to petroleum and natural gas is discussed. After that, the potential of oil and gas in the North Sea and the correlation to the North Sea states are investigated. The expected annual production rate and the influence on the supply situation of different states in Western Europe are analyzed. 33 refs.

12587 Energy prognoses yesterday and today. Forecasts more difficult still. Elfert, H. (Esso A.G., Hamburg (Germany, F.R.)). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 6, 281-285(Jun 1977). (In German).

In principle, energy demand prognoses consist of two separate parts: (1) an estimation of the future economic development; and (2) a determination on the basis of the past of the relationship between energy demand and economic activity. The article discusses the methods employed in energy prognoses. Up to 1973, all estimations were generally too low. Only after the oil supply crisis of 1973 did estimates account for a worldwide reduction of energy reserves and a higher energy price level. The uncertainties of present methods are pointed out. They have led to an increasing number of alternative solutions to meet the energy demand. 1 fig., 1 table, 11 refs.

12588 Energy 2000 not without nuclear power. Loennecke, G. *Oel;* **15**: No. 5, 132-133(May 1977). (In German).

The article is an abridged version of an analysis of the prospective energy supply of Western Europe in the year 2000, which was elaborated by the German BP. Estimates lead to the conclusion that Western Europe must save about 850 million tce (ton coal equivalent) by using energy more efficiently, in order to insure

a realistic energy supply while a considerate proportion would have to be covered by nuclear energy.

12589 Simulation of self-consistent energy forecasts. Devine, W.D. Jr.; Calligan, C.C.; Osborne, O.D.; Ringle, J.C. (Oak Ridge Assoc Univ, Tenn). *IEEE Trans. Syst., Man, Cybern.;* SMC-7: No. 4, 228-235(Apr 1977).

A socioeconomic computer simulation model for the State of Oregon is described. The Oregon State Simulation Model (OSSIM) includes a 37-sector model of electrical energy consumption. Coupling between this model and the OSSIM provides self-consistent scenarios of economic and demographic activity underlying energy consumption. Sample results illustrate differences in future electrical energy consumption in response to various sets of exogenous energy prices. Use of electricity in Oregon appears to be more dependent upon the relative cost of electricity to that of fossil fuels than upon the absolute cost of energy. One of the purposes of this project has been to help state-level policy makers understand the determinants of electricity consumption within a context of changing economic conditions. 10 refs.

12590 Development of world energy requirements and ways of meeting the demand. Valvoda, Z. *Jad. Energ.;* **23**: No. 1, 30-36(Jan 1977). (In Czech).

Past and future energy demand and the possibility is of using fossil and non-fossil energy sources in meeting the needs of population are discussed. The use of alternative energy sources is recommended to reduce the fossil-fuel demand, e.g., solar energy, water energy, geothermal energy, tidal energy, wind energy, sea wave energy, ocean temperature gradients, photosynthesis, glacier energy and nuclear fission energy. The comparison of the possible use of the respective types of energy sources shows that only geothermal energy, tidal energy, and nuclear energy produced by thermal reactors have undergone the whole developmental stage and are industrially applicable.

12591 Facts and possibilities for the energy problem. Koch, E. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Bauwesen). *Keram. Z.;* **29**: No. 3, 116-117(1977). (In German).

After the oil crisis, all countries have become more aware of the energy problem. The economic dictate of OPEC countries must be counteracted at least by a partial self-supply with energy. The article deals with a few selected, realistic developments on the energy sector. Among others, the following facts are discussed: pretroleum reserves in the FRG, coal liquefaction, efficiency of thermal power plants, alternative projects for nuclear energy, reprocessing of nuclear waste, and problems of nuclear waste storage.

12592 Security of the energy supply and rational use of energy. Conrad, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. fuer Angewandte Systemanalyse). *KFK Nachr.;* **9**: No. 1, 3-9(1977). (In German).

The security of the energy supply and the rational use of energy in the Federal Republic of Germany are investigated. The energy policy in the Federal Republic is directed along a sufficient, economical, environmentally safe, and secured energy supply. Recently, however, enironmental and reliability aspects have taken priority over the demand orientation and price value (supply safety). Furthermore, more and more importance is being given to a rational use of energy. The development trends are shown here by means of examples. 2 figs., 4 tables, 16 refs.

12593 What is our energy future. Hill, R.F. (Federal Power Commission, Washington, DC). pp 3-5 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Pessimistic forecasts made in 1976 that the energy problem will continue are reiterated at the opening remarks of the 1977 Energy Users Law Seminar. Blame is placed on a combination of foreign oil dependence, price controls, nuclear safety and environmental protection issues, and a worsening of weather conditions. Revisions have lowered the projected 1985 U.S. energy demand from 99 to 91 quadrillion Btus, which is still too high an increase over the 73 quadrillion Btus consumed in 1976. Other projections are made for an increasing share of electricity and the increasing use of coal and declining use of nuclear power to generate electricity. Increases are shown for oil consumption and oil imports and an increase in natural gas production only if there is an end to price controls. Alternative sources are expected to contribute less than one percent. These projections are not consistent with the amount of energy production needed to meet the expected demand. (DCK)

12594 Energy perspective: industry and legislation. Frank, A.L. (Federal Power Commission, Washington, DC). pp 6-9 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Industry is cautioned that present energy problems will continue for some time regardless of any legislation that is passed because of the time needed for exploration and new production to take effect. Some of the anticipated legislation will change distribution, but will not increase energy supplies. Delays in developing the Outer Continental Shelf, for example, are blamed on uncertainties in what form new regulations will take. Policies to increase coal production will introduce new pressures to lower pollution standards, build cleaner factories, and produce enough coal cars. Competition between railroads and slurry pipelines will require a Congressional decision on whether pipelines should have eminent-domain rights. Uranium-enrichment issues will add at least 10 or more years to any completed program. Industry, in the meantime, will have to plan for its own short-term solutions. (DCK)

12595 Sicherheits-, Preis- und Umweltaspekte der Energieversorgung. (Safety, price and environmental aspects of energy supply). Dolinski, U.; Ziesing, H.J. Berlin, Germany, F.R.; Duncker und Humblot (1976). 303p. (In German).

An attempt is made in the present investigation, based on a problem analysis of the most significant complexes for the power industry, namely the safety, price and environmental aspects, to obtain the development of a target system upon which the results of status-quo prognoses can be measured. A basis for rational decisions is thus to be made in the energy policy.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 12268, 12544, 12555, 12572, 12580, 12581, 12582, 12583, 12584, 12593, 12594, 12610, 12611, 12616, 12619, 12625, 12626, 12634, 12650, 12651, 12652

12596 (IPC—76-44) Toxic Substances Act. Walsh, D.P. (Shell Oil Co., Houston, Tex. (USA)). 1976. vp. (CONF-7604139—2). Petroleum Refiners Association, Washington, DC.

From 1. international petrochemical conference; San Antonio, TX, USA (4 Apr 1976).

The legal responsibility for the production of safe products is discussed. All products of the oil, petrochemical, and chemical industries that can be made, transported, stored, processed, used, and disposed of are under surveillance. Attorney Walsh specifically discusses two principal areas regarding product safety where government is acting. They are, first, the Toxic Substances Legislation currently being considered in Congress and, second, the present trends in the courts with regard to product liability law. (MCW)

12597 Federal units concerned with energy. *Power (N.Y.);* **121**: No. 9, 39, 68-70(Sep 1977).

Information is presented about some half-a-hundred Federal government units having major or minor concern with energy matters. These include units in the Executive Office of the President, independent agencies, Cabinet departments, and Congressional committees. With each there is a brief outline of its responsibilities and activities. This is a selection of units with substantial energy concerns; it is not a "complete" list. It should also be noted that this is the situation as it was just before the recent setting up of the Department of Energy. it thus includes agencies and functions that have now become a part of DOE. Addresses and telephone numbers of the units concerned are given.

12598 Responsible energy policy from today's viewpoint. Reintges, H. *Glueckauf;* **113**: No. 10, 518-523(19 May 1977). (In German).

Future energy demand of the Federal Republic of Germany is analyzed and aims of policy are set. Decrease of oil imports and coordination of natural and coal gas resources is recommended. Nuclear and coal power plants for electricity generation are given priority.

12599 Energy program of the government of the FRG: conceptions and reality. Lembke, H. *Energiewirtsch. Tagesfragen;* **27**: No. 5, 322-328(May 1977). (In German).

The author points out the overall conception concerning energy policy by giving a short survey of the energy program of the FRG running since 1973. In particular, the objectives set up in the first projection of the energy program are compared with the values attained in reality concerning mineral oils, natural gas, pit coal, brown coal, and nuclear energy. From this comparison, conclusions are drawn on the possibility to attain the objectives set up for 1980 and 1985. These objectives can hardly be realized without making compromises. Essentially, a gap in the supply of nuclear power stations is only to be closed by using nuclear energy and hard coal.

12600 Responsible energy policy from today's viewpoint. Reintges, H. *Glueckauf;* **113**: No. 10, 518-523(May 1977). (In German).

The basis for all considerations and measures concerning energy policy are the future energy demand and the possibilities of covering it. Energy demand prognoses of various institutions are cited. The main part of the article starts on a discussion of basic aspects of a successful energy policy and then deals with concrete targets of energy policy: the necessity of a rational and efficient use of energy and problems of the use of different primary energy carriers (oil, gas, nuclear energy, coal). The target of any energy policy should be the supply of low-cost energy, thus maintaining and improving the competitiveness of the industry.

12601 Outlines and basic values of the energy program. *Oel;* **15**: No. 4, 99-101(Apr 1977). (In German).

In the summer of 1977, the energy program of the Federal Government is to be continued and thus brought up to date. As a basis and as a statement of their intention, the government passed, by cabinet decision, a few guidelines and basic data on which the future energy policy is to be based according to the momentary state of knowledge. The period of time covered by the projection leads up to 1985, sometimes forecasts up to 1990 are made.

12602 Energy in competition. Energy policies influence the labour market. *Energie;* **29**: No. 3, 46-48(Mar 1977). (In German).

A growing economy needs more energy. On the other hand, more enconomic growth means fewer unemployed. These questions are discussed in the article at hand under the aspects of future energy policies. The discussion is based on 3 studies of industry and Federal organizations: (1) construction and operation of fossil-fuel power plants and the haulage of German coal required for these plants (DIW study Dec. 1976); (2) effects of a nuclear energy moratorium on the electric power supply and the economic situation of the FRG (Kraftwerk Union, Feb. 1977); and (3) memorandum on energy policies in Northrhine-Westphalia / nuclear energy - coal (Government of the Land of NRW, March 1977). 5 figs.

12603 Is America better off. Aspects of American energy policies. Grawe, J. (Ministerium fuer Wirtschaft, Mittelstand und Verkehr Baden-Wuerttemberg, Stuttgart (Germany, F.R.)). *BP Kurier;* No. 1/2, 3-7(1977). (In German).

The chances of guaranteeing energy supplies in the U.S.A. in future times are much better than in the German Federal Republic, last but not least on account of large coal and uranium deposits and climatic conditions that are more favorable for the utilization of solar energy. Starting by presenting the development of the energy situation within the last years, the author describes fundamental characteristics of the energy policy of the U.S. Part of this policy is the draft of an energy research program by the E.R.D.A., the basic elements of which are discussed. The legal bases concerning a number of activities have been created by the two energy laws of 1975 and 1976. The utilization of nuclear energy for the supply of the U.S. is paid special attention. Finally, possible repercussions of the U.S. energy policy on the Federal Republic of Germany are dealt with.

12604 Great power rivalry in the Far East: the geopolitics of energy. Ebinger, C.K. Washington, DC; Center for Strategic and International Studies (1977). 52p. .

The interlocked economic and strategic patterns in the western Pacific are evaluated since the death of the region's most powerful figures, Chou En-Lai, Chiang Kai-shek, and Mao Tse-tung. U.S. security arrangements, traditionally in the past two decades firmly tied to Japan's defense policies, are now cast into doubt as a result of the People's Republic of China's oil potential and also the Soviet Union's efforts to exploit its own Asian fossil-fuel resources. Chapters covered in this monograph are: Petroleum Projects in the People's Republic of China; Japanese-Soviet Relations; Sino-Japanese Relations; The Taiwan Problem; and USSR-Littoral State Conflicts. (MCW)

12605 Conference on National energy policy. Washington, DC; American Association for the Advancement of Science (1977). 151p. (CONF-770589—). .

From Conference on national energy policy; Washington, DC, USA (17 May 1977).

President Carter's National Energy Plan was examined and evaluated during this conference. The conference was arranged to provide a forum for the presentation and discussion of viewpoints on the proposed National Energy Plan from independent experts in energy and related fields. Issues under discussion fell into the following categories: Supply of Oil and Gas; Government Role; Import Limitations; Conservation; Stimulation of Domestic Fuel Supplies; Economic Considerations; Environmental Issues; and International Implications. Following the Welcome by Senator Henry Jackson, presentations were made by Philip H. Abelson, Walter J. Mead, Robert A. Charpie, John H. Gibbons, Chauncey Starr, Lester B. Lave, Henry R. Linden, Milton Russell, and S. Fred Singer.

12606 Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977). 198p. (CONF-770147—).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

These proceedings are intended to provide practical information to non-lawyers, namely businessmen, engineers, scientists, government officials, and others affected by the new laws and regulations. A separate abstract was prepared for each of the 13 papers presented under the following categories: Energy Perspective (2 papers); Oil and Propane (1 paper); Coal (2 papers); Natural Gas (2 papers); Conservation (2 papers); Electric Rates (3 papers); and Legislative Prospectus (1 paper). In addition, an abstract was prepared for the "Emergency Natural Gas Act of 1977", which was reprinted in an appendix.

12607 Energy legislative prospectus for 1977. Graham, J.C.R. (Dept. of Commerce, Washington, DC). pp 169-180 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

A continuum of anticipated energy legislative issues for 1977 is presented. Major issues are expected to concern access to energy resources, financing and regulation of energy development, energy transportation and transfer, processing and disposal, and consumption. Each of these issues is summarized and evaluated in terms of the intent and nature of bills that are under consideration or are expected to be initiated. Recommendations are made for energy users to keep abreast of the background and implications of these issues so they can participate in the legislative process. (DCK)

FOSSIL FUELS

REFER ALSO TO CITATION(S) 12551, 12586, 12598, 12649, 12656

COAL

REFER ALSO TO CITATION(S) 11599, 12653

12608 Place of coal in the energy market. Davies, D. (Natl Coal Board). *Min. Eng. (London);* **136**: No. 194, 615-618(Jul 1977).

The author argues that through its Plan for Coal the British coal industry is settling itself in good shape to meet the fuel needs in the latter years of this and into the next century when reserves of other fossil fuels will be greatly depleted. There are, however, short-term problems in the market which must not be allowed to divert the industry from its longer-term objective, and the author discusses market by market the problems and short- and longer-term action required to be taken.

12609 Joint research work in the field of coal refining is carried out by the german coal mining industry. Peters, W. (Steinkohlenbergbauver/Bergbau-Forsch, Ger). *Coal Miner;* **2**: No. 2, 11-14, 18(Jun 1977).

The ready application of the results obtained by research and development were the reason that German coal could maintain its central position within the energy economy of the Federal Republic of Germany; despite the difficulties which the German coal mining industry had to face during the past 15 years due to the strong competition of petroleum and natural gas. A basis was established that, at long range, coal will be available as a nonpolluting and low-cost energy source.

12610 Coal: energy for the future. Holmes, C.D. (National Coal Association, Washington, DC). pp 51-73 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

The lack of a coal policy has meant that, while coal is to be our major source of energy, legislation that is passed will either impede or make it easier to mine, move, and burn coal. The logic of emphasizing coal is apparent in view of the size of U.S. coal reserves relative to oil and gas. The coal industry is confident that it can meet the challenge of increasing production if managerial and legislative obstacles are dealt with. Managerial problems include the recruiting and training of miners for efficient production while keeping health and safety as a top priority. The industry can initiate people-oriented programs that will accomplish this and increase productivity at the same time. These programs should include better relations between labor and management and between regulators and the regulated, new mining and transportation equipment, and a better climate for capital formation. Legislative constraints in the area of strip mining have been shifting from Federal to state and industry control in recent years. Federal environmental and leasing laws at this stage

could serve to impede productivity. Legislation requiring oil companies to divest their coal holdings and industrial plants to meet the Clean Air Act standards are viewed as counterproductive. (DCK)

12611 Coal utilization. Buck, L.E. (Patton, Boggs and Blow, Washington, DC). pp 74-89 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

The Energy Supply and Environmental Coordination Act of 1974 (ESECA) was designed to authorize coal conversion for existing plants and coal utilization for new plants. The law's intent, provisions, and implementation procedures are summarized. Pertinent definitions are given for clarification. The sequence of prohibition, construction, and supply orders is listed and defined. A summary is given of the law's requirements for findings, coal allocations, data compilation, and reporting intervals. (DCK)

PETROLEUM

REFER ALSO TO CITATION(S) 11642, 11656, 11657, 11658, 11659, 12604

12612 Future role of the national oil companies in the world petroleum industry. Taher, A.H. (Governor of Petromin). *OAPEC News Bull.;* **3**: No. 11, 14-21(Nov 1977).

Abridged text of paper presented to 1977 OPEC seminar, Vienna, October 10-12, 1977.

The history and role of national (i.e., multinational companies owned by an oil-exporting or -producing country) oil companies are outlined as they relate to international political and economic events. The governments of oil-exporting countries saw national oil companies as a way to gain some control over prices and revenues and to participate in development and marketing decisions. National companies can be more responsive to government policies than multinational companies during times of shortages. They provide a business arm to the government, which is politically involved in supply negotiations with other governments. National companies are felt to have a more stable position in terms of supplies, although their supplies may not be any more abundant. Multinationals will need increasingly selective investment activities after 1980 as government regulation and intervention changes market conditions. National companies may want to turn the marketing of crude oil over to the multinationals, while cooperating with them in exploration projects and the transfer of alternative energy technology. (DCK)

12613 Performance efficiency of the national petroleum companies. Amin, M.S. (Assistant Secretary General). *OAPEC News Bull.;* **3**: No. 10, 9-15(Oct 1977).

The National Petroleum Companies of the Arab states declare their goals of (1) increasing petroleum reserves by adjusting oil prices to encourage new discovery and raising the rate of recovery of existing reservoirs; (2) conserving petroleum by setting an ideal rate of production and utilizing natural gas in oil fields; (3) processing petroleum into more efficient petroleum products; and (4) integrating the industry so as to continue international cooperation within the cartel. Statistics are developed to show production levels for each of the major oil producing countries during the 1960-1975 period. Other tables compare the percentages of utilized to produced natural gas and the percentage of refining capacity to oil production. (DCK)

12614 Kuwait's plans to enter the field of petrochemicals. Al-Nouri, A.B. *OAPEC News Bull.;* **3**: No. 10, 29-35(Oct 1977).

Production and market data from eleven years of fertilizer production are summarized to demonstrate the logic of Kuwait's diversification, this time into the basic and intermediate petrochemicals. Kuwait's entry into the petrochemical products market began with a natural gas-based nitrogenous fertilizer in 1964 with production by the Petrochemical Industries Company (PIC). Justification for this new step is based on the local availability of raw materials, financial resources, the market potential for petrochemicals, and Kuwait's economic need to develop its single resource. Market surveys and product criteria led to the selection of benzene and ethylene. Project plans for entering these two fields are outlined. PIC will participate in some joint ventures outside Kuwait, capitalizing on its abundant feedstock, capital, and developed infrastructure in return for management and technical expertise. (DCK)

12615 Retrospective survey of the oil supply of Western Europe. The oil supply crisis and its impact. Harms, K. *Oel;* **15**: No. 3, 60-65(Mar 1977). (In German).

A review of Western Eeurope's supply in crude oil and petroleum products during the five-year period from 1971 to 1975 shows that the oil crisis of 1973, while having a marked impact on the supply pattern, has so far failed to unsettle the basic structure. 2 figs., 9 tables.

12616 Federal Energy Administration price and allocation regulations. Buck, L.E. (ed). (Patton, Boggs and Blow, Washington, DC). pp 13-47 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

The development of price and allocation policies is put in historical perspective by outlining contributing events and legislation. The implementation of price controls is shown to have had the greatest impact through the Energy Policy and Conservation Act and the Energy Conservation and Production Act. Federal Energy Administration regulations on petroleum prices affect the producer, refiner, reseller, and retailer. Background information is given on how each of these levels functions within the constraints of price controls. Goals of the Emergency Petroleum Allocation Act are followed by a summary of ensuing regulations and their impacts. Regulations governing two products, crude oil and refined products, are outlined chronologically. Explanations are given of allocation fraction, adjustments to base-period volumes, curtailments, and state emergency programs. Some products, such as aviation fuel, propane, and motor gasoline, have separate provisions. The social and economic implications of these laws are explored as they relate to rationing, exception, inequities, procedures, and penalties. 66 references. (DCK)

NATURAL GAS

REFER ALSO TO CITATION(S) 12614

12617 Three phases of the evolution of Algerian policy for natural gas sales. Mazouni, T. (Department Gaz Sonatrach, Algiers). *OAPEC News Bull.;* **3**: No. 11, 8-13(Nov 1977).

From 5. international conference and exhibition on liquefied natural gas; Dusseldorf, Ger. (29 Aug 1977).

Algeria's liquefied natural gas (LNG) policy is based on a combination of abundant and accessible reserves with a willingness to exploit its natural resources in order to achieve a major role in international trade. Studies by Sonatrach examine the marketing changes that have evolved in the world energy market since Algeria began the LNG movement in 1964. The study concludes that competition between petroleum and natural gas for markets needs constant modification to make up for the relative inflexibility of the LNG industry. A review of sales contracts reveals a three-phase evolution. Phase one (1964 to 1971) selling prices were based on actual cost as Sonatrach sought European and U.S. markets on the basis of LNG's desirability as a fuel and its future profitability. Phase two (1972 to 1973) prices rose during a period of significant growth as world energy supplies and environmental constraints changes. Prices were based on competing energy sources and were set according to an indexing formula, which protected the buying power of revenues and stabilized contracts through a safeguard clause. Sonatrach reevaluated its pricing procedure after 1974 and adopted the present minimum price index, re-assessment of market conditions every four years, mandatory approval of transactions by the governments of the parties, and added renegotiating flexibility. (DCK)

12618 LNG 5 call for gas investment to plug energy gap. Swiss, M. *Energy Int.;* **14**: No. 11, 36-38(Nov 1977).

Delegates to the Fifth International Conference and Exhibition on Liquefied Natural Gas (LNG) called for greater investment in developing and transporting LNG as a way to fill the coming energy gap. Sonatrach, outlining world natural gas reserves, has pursued markets for LNG in Europe while the U.S. remains undecided about it. The Algerian company urged a massive investment in a hundred each of liquefaction and revaporization plants and in a thousand carriers while stressing the need to keep prices and currencies stable to avoid depleting reserves too fast. Papers were presented on the financial and contractual arrangements that will be required. The outlook for LNG is not seen as promising in light of the U.S debate over a national energy plan. The merits of LNG were presented along with proposals for its use and its advantages over synthetic natural gas (SNG). (DCK)

12619 A Senator looks at the future of natural gas: an interview with Senator J. Bennett Johnston, Jr. (conducted by Robert L. Hill). *Public Util. Fortn.;* **100**: No. 9, 25-28(27 Oct 1977).

Senator Johnston of Louisiana expressed in an interview his positions on the National Energy Bill as it was sent to conference. He supports deregulating natural gas and using the market system to gradually add intrastate gas into the interstate system in a way that will protect consumers in producing states. He would not include incremental pricing until a full study of rate structures has been made. Senator Johnston foresees a worsening of regional tensions as a result of energy shortages and government allocations. He sees a need for utilities to reconcile the competing drives for profit and low rates to the public's satisfaction. He opposes having utilities involved in home inspection and insulation projects unless they are already

doing so because of the potential for competing unfairly with the private sector. He also opposes the Outer Continental Shelf bill because it will add too much regulation, increase capital costs and delay development. He recommends policies to ease the siting of energy facilities, including those for liquefied natural gas. (DCK)

12620 Environmental impact of natural gas. Hibberd, C. (British Gas Corp., London). *Int. J. Environ. Stud.;* **11**: No. 2, 99-112(Sep 1977).

This paper outlining the environmental impact of natural gas firstly describes the recent and increasing importance of gas in Western Europe, and its discovery in the North Sea. The effects resulting from its utilization are also described. These include the effect on the implementation of the Clean Air Act and the changes brought about in land use pattern. In making the commodity available to the consumers, the gas is brought ashore to the reception terminal and transported by a national pipeline system which is made more efficient by the construction of compressor stations. The various stages of this immense operation are described as are their associated environmental problems. The methods by which these are kept to the minimum possible while operating under other constraints is also detailed. A further necessary stage of the operation is gas storage made essential because production cannot be economically made to coincide with demand. Technological advance has enabled methods of storage to be developed by which disruption is minimized. This aids the distribution to the final consumer by a complicated system eventually reaching the street mains. Thus the fuel is brought directly to the point of consumption with a minimum of environmental impact.

12621 Increasing importance of LNG in public natural gas supply. Brecht, C. (Deutscher Verein von Gas- und Wasserfachmaennern e.V. (DVGW), Frankfurt am Main (Germany, F.R.)). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 8, 321-323(Aug 1977). (In German).

From 5. international congress and exhibition on liquefied natural gas; Duesseldorf, Germany, F.R. (29 Aug - 1 Sep 1977).

On the occasion of the 'LNG 5' congress, a survey is presented of the worldwide economic and technical importance of LNG. The four main subject groups of the conference are pointed out: 1) The role of LNG in the energy supply of the world; 2) LNG techniques and technical and economic questions; 3) financing, judicial problems, and political questions in connection with LNG trade; and 4) LNG transport.

12622 Reasons for decision: northern pipelines. Volume I. Ottawa; National Energy Board (1977). vp. and Publishing Supply and Services Canada, Ottawa $18.00 per set of 3 volumes.

Exploration and discoveries of minerals in the North American artic region are reviewed briefly, particularly efforts leading to the formation of oil and gas pipeline companies. The applications made by the various companies were then heard by members of the National Energy Board. This report deals with the various applications as amended either before or during the hearing. The Board held 214 days of public hearing and received some 1,200 exhibits and some 900 public documents. The main subjects covered in this volume are an analysis of whether a pipeline is needed, based on forecasts of supply and requirements. Technical feasibility and engineering specifications of facilities and contracts, financial, and economic matters are included in Volume 2. Socio-economic and environmental matters are discussed in Volume 3. Under each of the main headings or subheadings, the Canadian Arctic Gas Pipeline Limited (CAGPL) application is dealt with first, followed by the Foothills Group, and then the Foothills (Yukon) Group applications. Alberta Natural Gas Company Ltd. ("Alberta Natural" or "ANG") is included within the CAGPL Project sections. (MCW)

12623 Reasons for decision: northern pipelines. Volume II. Ottawa; National Energy Board (1977). vp. and Publishing Supply and Services Canada, Ottawa $18.00 per set of 3 volumes.

Continuing with the hearings on applications made to construct a natural gas pipeline in the North American arctic, Volume 2 contains 2 chapters: Engineering Design and Technical Feasibility and Contractual, Financial, and Economic Matters. Maps furnished by Canadian Arctic Gas Pipeline Limited (CAGPL), the Foothills Group, and the Foothills (Yukon) Group are included. Alberta Natural Gas Company Ltd. is included within the CAGPL Project. (MCW)

12624 Reasons for decision: northern pipelines. Volume III. Ottawa; National Energy Board (1977). vp. and Publishing Supply and Services Canada, Ottawa $18.00 per set of 3 volumes.

Volume 3 of the hearings on applications to construct a natural gas pipeline in the North American Arctic region contains chapters 5 and 6, Regional and Socio-Economic Impact and Environmental Impact. Chapter 5 specifically deals with the regional socio-economic impacts of the Mackenzie Valley and Alaska Highway proposed pipeline routes. Chapter 6 deals with the environmental impacts. The three applicants submitting reports were the Canadian Arctic Gas Pipeline Limited (CAGPL), the Foothills Group, and the Foothills (Yukon) Group with Alberta Natural Gas Company Ltd. included in the CAGPL Project. Maps are provided for each Project. (MCW)

12625 Confronting the natural gas energy crisis. Watt, J.G. (Federal Power Commission, Washington, DC). pp 93-106 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Changes in the law governing the Federal Power Commission (FPC) are recommended so that cost rather than value becomes the basis for pricing natural gas. This would allow market forces to prevail and would increase supplies of natural gas. The effects and national impact, both adverse and beneficial, of energy curtailments are summarized by a spokesman of the FPC. Short-term emergency purchases and curtailments are not considered damaging to the country, although it is noted that areas served by regulated interstate pipelines have suffered the greatest hardship. The response to the hardships of last winter reveals how little industry and the country as a whole has heeded warnings of an emerging energy shortage. The FPC's role needs to be redefined to permit the development of energy technologies by private enterprise. Until new legislation is enacted, the FPC will concentrate on existing regulations that encourage better storage and distribution planning. (DCK)

12626 Analysis of the Emergency Natural Gas Act of 1977. Barsch, H.E. Jr. pp 107-120 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Implementation of the Emergency Natural Gas Act of 1977 is analyzed in the context of the President's authority to allocate natural gas among interstate pipelines and his authority to permit gas purchases on a short-term emergency basis. The provisions of the law are summarized and defined. The potential for confusion and conflict with the Natural Gas Act are noted and the need to continue an independent emergency procedure is questioned. Economic losses to pipeline customers and distributors are not compensated by the Act. The pipelines and distributors who have independently supplemented their gas supplies are vulnerable to Presidential appropriation, a situation that could discourage future efforts to increase gas production and supply. The President's authority over pricing is felt to be too vague. (DCK)

12627 Emergency Natural Gas Act of 1977. pp 191-198 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Public Law 95-2, the Emergency Natural Gas Act of 1977, is reprinted. The Act authorizes presidential intervention in the transport and delivery of natural gas on the basis of priority during periods of shortages and in the purchase of natural gas to meet short-term emergencies. The President is empowered to determine when an emergency exists and is required to report his actions to Congress. Procedures and restrictions are defined for implementing the Act. (DCK)

12628 Appendices to Indiana Natural Gas: accommodation to reality. A task force study of the current natural gas supply situation and the potential relief available from alternative energy sources. Indianapolis; Indiana Gas Corp. (1 Feb 1976). 44p. (NP—22190).

The Subcommittee on Energy of the Lieutenant Governor's Science Advisory Committee is listed to form Appendix A. Appendices that follow are: FPC Natural Gas Priorities; Coal Reserves in Indiana by County, January 1, 1974; Indiana Coal Consumption—1974; Background Report on Biogas Prospects for indiana; Background Report on LNG for the State of Indiana; and Background Report on Underground Gas Storage. (MCW)

12629 Problem of reliability and backup of a unified gas-supply system. Garlyauskas, A.I.; Gerchikov, S.V.; Il'kevich, N.I.; KUznetsov, Yu.A. *Power Eng.;* **14**: No. 1, 84-95(1976).

The principal aspects of investigating the reliability of the unified gas-supply system (UGS) are considered along with the place occupied by this problem in optimal planning and design of the UGS, the peculiarities of backup and of increasing the reliability of gas supply and determining the indices by which they are estimated, various possible methods for producing system reliability, and the related methodological problems of optimizing and equalizing the elements of the UGS. On the basis of the results, the principal problems of further investigations of the reliability of gas supply are formulated. 18 refs.

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 12551

12630 (COO/4128—1, pp 369-439) **Draft cost—benefit analysis for two energy-saving technologies.** Zerbe, R. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

A simplified example of cost-benefit methodology applied to two energy-saving technologies is presented. These are not to be taken as finished cost-benefit evaluations, but as examples accurate within the specified limitations and assumptions. The first technology examined is home storage heating. The conclusion for this technology that substantial net benefits exist from its adoption is a strong one, in spite of limitations of the analysis. This is because an a fortiori procedure was adopted by which the calculation of net benefits was biased downward, and because no important negative externalities seem to exist for this technology. The importance of mechanisms for transferring at least some of the benefits from this technology to its users was emphasized and analyzed. The relationship between profitability to customers and social net benefits via the rate at which the technology was adopted is shown. The second technology, compressed-air energy system, is in a more primitive state of development. Hence, the cost and benefit calculations are much less certain than for the first technology. It would appear that economic feasibility will depend on developments that lower capital and/or operating costs and on the magnitude of negative externalities. Assuming this technology is feasible, which appears likely given probably cost declines, a further question arises as to when it should be brought on line; a method is presented by which this could, in principle, be determined.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 12259, 12541, 12552, 12557, 12571, 12598, 12606

12631 (BNWL—2412) **Assessment of the effects of thermal power plant site and design alternatives on the cost of electric power.** McGinnis, K.A.; King, J.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1977. Contract EY-76-C-06-1830. 49p. Dep. NTIS, PC A03/MF A01.

A method for quantitatively determining the effect of new fossil fuel and nuclear electric generating facilities on the cost of power in the service region and local community is proposed. The resulting index of economic impact is intended for use in a methodology for assessing power plant site and design alternatives. The overall assessment methodology incorporates community values with technical assessments of impacts, providing a system for assessing preferred power plant site/design alternatives from the community's perspective. Eight decision criteria were selected for the overall site assessment methodology.

12632 (CONF-770659—) **United States/European workshop on power system related research.** Fink, L.H.; Carlsen, K. (eds.). (Energy Research and Development Administration, Washington, D.C. (USA)). 1977. 153p. Dep. NTIS, PC A03/MF A01.

From US/European workshop on power systems related research; Ortisei, Valgardena, Italy (6 Jun 1977).

The objective of the workshop was to strengthen U.S. and European power system related research programs by encouraging increased direct interaction between research investigators working on related problems. The agenda included brief reviews of ongoing and planned research programs; a discussion on research program planning and management; discussion of high priority problems in power system planning, operation, and control; discussion of the adequacy of existing programs addressing those areas. The final session summed the results of the two previous sessions. (MCW)

12633 (COO/4128—1, pp 22-56) **Federal role in energy research: the case of electricity generation.** Sjaastad, L.A. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

This paper deals with the role of the Federal government in energy research, particularly with respect to the creation of new technology for electric power generation. Section II consists of a brief review of the general problem of providing adequate incentive for privately executed research and development activity and outlines the case for state intervention in both a direct and indirect nature. Section III concerns the special circumstances of the electric power generation industry as it has evolved in the U.S., with special emphasis on the manner in which that "natural" monopoly is regulated. Section IV concerns externalities associated with the normal operations of the power industry, and Section V deals with the problem of pricing output, and its relation to incentives for creation and adoption of new technology on the part of both producers and consumers of electric energy. The final section deals with the dimensions of the Federal role and summarizes the recommendations.

12634 (COO/4128—1, pp 69-100) **Theory of regulatory constraint and electricity utility storage: some preliminary results.** Spann, R.M. Sep 1977.

In Methodology of evaluating research and development projects. Final report.

Traditionally, evaluation of new or alternative technologies assumes that firms choose the least-cost method of producing any given output. This approach may not be totally correct when evaluating choices involving alternative technologies in electric utilities. The model of Averch and Johnson (1962) has been used traditionally to analyze the regulated firm, but its original result, i.e., over capitalization, may be no longer valid. The reasons are given and then the effects are considered of a number of regulatory policies or constraints on firm behavior on the incentives for utilities to adopt storage devices. Regulatory policies that increase and decrease the incentives for storage are summarized. The analytical framework developed views regulation as placing constraints on firm behavior in the form of accounting rules which constrain revenues, pass through provisions, and the rate of return. These models may be extended to include nuclear versus coal plants, high-voltage interconnection versus non-interconnection, and pricing policies of regulated firms. The Averch-Johnson model is reviewed. 16 references. (MCW)

12635 (P—5894) **Electricity ratemaking: overview.** Acton, J.P. (Rand Corp., Santa Monica, Calif. (USA)). May 1977. 17p. Corp., Santa Monica, CA $1.50.

The author discusses work in progress at the Rand Corporation on electricity rate structures. He briefly highlights some of the most significant findings and conclusions, namely: (1) U.S. industry can respond to peak-load pricing of electricity, reducing costs, and substantially benefiting business and consumers; (2) expected savings in operating and capital costs to U.S. electrical utilities from these changes are significant; (3) for residential and small commercial customers there is more uncertainty about the amount and nature of response to peak-load pricing, and additional information is needed before a universal policy should be implemented; and (4) peak-load pricing of electricity will require certain equipment and administrative changes, but it is not intrinsically more difficult to implement and administer than traditional electricity rate structures. (MCW)

12636 **Development of electricity supply costs in the next decade and its effect on electricity prices.** Rittstieg, G. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 16, 530-536(Aug 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

First, the author describes the development and structure of the costs for public electricity supply since 1960, and their probable further development up to 1985, by using a cost model. The cost and price level, which were stable up to the end of the sixties were—as a result of the generation costs which have risen continuously since then—followed by a steeply rising phase; when compared with the nadir in 1969 (= 100%) the average electricity supply costs will rise by at least 80% by 1985. Secondly an investigation is made by the author into the conclusions to be drawn from this cost development for the electricity prices. 14 figs., 8 refs.

12637 **Forecasts of energy demand in the electricity supply industry and their practical application.** Schnell, P. (Energie-Versorgung Schwaben A.G., Stuttgart (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 16, 521-530(Aug 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

Within the electricity supply industry, reliable forecasts carry greater weight than in other fields; planning that takes a view of the future and deals with long periods is of special importance. The author therefore attempts to outline the most important types, characteristics, and methods of forecasting, together with their purpose and limitations. He finds that forecasts cannot serve to indicate clearly future developments; it is possible with their aid to present only possible directions of development, and the possibilities of their achievement exhibit a varying probability. By using examples he shows to what extent deviations were found between earlier forecasts and the development that acually took place. Finally, the author adumbrates a forecast of future electricity generation in the Federal Republic of Germany and discusses the meaningful and mistaken interpretation of forecasts. 14 figs., 20 refs.

12638 **Electric power consumption increases with economic development.** *Energie;* **29**: No. 6, 169-172(Jun 1977). (In German).

Statistical data in the Federal Republic of Germany show that trend of increased consumption of electric power is directly propor-

tional with the economic development. The need for new coal-fired power plants is indicated.

12639 Questions of the day in the electricity supply industry. Schenk, P. (Vereinigung Deutscher Elektrizitaetswerke e.V. (VDEW), Frankfurt am Main (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 12, 371-374(Jun 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

The author deals with the especially important points that have given rise to the situation in the German electricity supply industry since the oil-price crisis, and in particular in the year 1976. He then turns to the present urgent problems facing the supply industry. The following are discussed: the energy program; meeting the power demand; nuclear energy from licensing up to the disposal of the waste material; use of conventional power stations; actions by associations/initiatives; saving of energy; promotion of energy consumption by advertising; and power/heat coupling.

12640 Undertaking planning game for the electricity supply industry. Troescher, H. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.). Abt. Waermewirtschaft). *Elektrizitaetswirtschaft;* **76**: No. 13, 389-396(Jun 1977). (In German).

Planning games have been found satisfactory in many field in political and economic life. In particular the more convenient access to electronic calculators has made a contribution to their wider use. It is therefore surprising that the first planning game that has become known for the electricity supply industry was first published in the year 1975. This is the planning game for the Bernischen Kraftwerke AG, which is based on a simplified model of a small electricity supply undertaking (EVU). This planning game was adapted in the RWE to the conditions in larger EVU and a few additional model components were added. Besides the general points of view on planning games for EVU the author deals with the extended planning game which is termed in the article PEW. 13 figs., 1 ref.

12641 Electro-economics: responsibilities and investments for the future. *Energie;* **29**: No. 6, 161-165(Jun 1977). (In German).

The article portrays the main aspects of the annual meeting of the Vereinigung Deutscher Elektrizitaets-Werke (VDEW) held in Munich May 24—26, 1977. Central points of the meeting were assurance of supply, protection of the citizen, and questions concerning the labor market, in relation to anticipated investments. 4 figs., 9 tables.

12642 Personnel planning and management development in electricity undertaking. Warriar, S.K. *URJA;* **1**: No. 6, 20-21(Jun 1977).

Programs at the Indian Institute of Management, Bangalore, being made available to electric power industry personnel are discussed. Programs are designed with the help of personnel from that industry. Arrangements for continuous education programs are recommended. (MCW)

12643 MP and E's electric utility report. Where we are: electric power in Canada. *Mod. Power Eng.;* **71**: No. 5, 52-58(May 1977).

From Canadian Electrical Association's Engineering and Operating Division meeting; Montreal, Quebec, Canada (1977).

Highlights of a recent meeting are reported under the following headings: electric power in Canada; developments in utility technology; utilities assess load management benefits; outage statistics improve system reliability; what is CEA doing in research; major trends in utility technology; nuclear power developments here and abroad. The growth in national consumption of electricity for 1976 was 7.1%. The highest regional increase was 15.5% in Newfoundland. Plans for new nuclear and conventional power plants are surveyed. Some new developments in the technology of power generation are briefly reported.

12644 Voltages and reactive output scheduling in an electric system. I. Analysis of optimization criteria. Capasso, A.; Mariani, E. (Univ di Roma, Italy). *Energ. Elettr.;* **54**: No. 4, 184-194(Apr 1977). (In Italian).

The problem of voltage and reactive output scheduling in an electric system is dealt with by proposing a methodology for the choice of optimization criteria. The means available in a network to carry out voltage and reactive check are listed, and the bounds to be complied with are emphasized. Possible targets to be imposed in order to determine treatable or control variables are then examined, pointing out that it is not always possible to completely separate the scheduling of voltage and reactive power from active power. In this sense it is advisable, at least for networks having high power flux, to aim at operating generators so as to have at disposal maximum regulation margins. The choice of this aim made it possible to evaluate whether some criteria--which are actually assumed in various procedures of optimal load flow--may be taken as local or centralized operation standards. It is pointed out, however, that the criteria which better secure an operation system with maximum saving, may be less suitable than others to make the maximum regulation margins available, namely, to face unforseen increase of reactive and active load.

12645 Reconstruction of the Austrian electricity industry after the second world war. I. Sequenz, H. *Oesterr. Z. Elektrizitaetswirtsch.;* **30**: No. 3, 72-81(Mar 1977). (In German).

The first part of this report deals with the factors that led to the reconstruction of the Austrian electricity industry and then discusses the background of the Oesterreichische Elektrizitaetswirtschafts-AG (Verbundgesellschaft) and the Special Companies ("Sondergesellschaften"), which form the Verbund combine. The state of the electricity supply facilities at the end of the war as well as the facilities provided in the course of the post-war reconstruction program and those constructed to meet the growth in electricity consumption are mentioned. The names of the persons who have played an important part in this development are given.

12646 Important task of acquisition: lowering costs in power procurement. Hugel, G. *Maschinenmarkt;* **83**: No. 25, 451-455(Mar 1977). (In German).

The profitability of a process is determined, among other factors, by energy costs. The article is concerned with the cost of electrical energy. The energy supply undertakings are considered after evaluating a variety of tariffs: household tariff, industrial tariff, industrial power tariff, agricultural tariff, small consumers tariff, light power tariff, flat-rate tariff, and load price tariff. In every case it is necessary to determine the most-favorable type of tariff, where one must also take into account special consumers' contracts. Suitable tariff conditions are pointed out. 4 figs., 1 table.

12647 Power generation in Canada to 2000 a.d. Broe, K.L. (Can Gen Electr Co Ltd, Montreal, Que). *IEEE Trans. Power Appar. Syst.;* **PAS-96**: No. 1, 38-43(1977).

This paper covers the power generation forecasting work done from June to December 1973, as part of the strategic planning process for Canadian General Electric's Power Generation business. The forecast covers the period 1973 to 2000 and includes all hydraulic turbines and generators, fossil and nuclear turbine-generators, and gas turbine-generators, that are expected to be installed in Canada for each year in this little frame. The method used is described, a summary of the results is shown, and the relationship of the forecast to the strategic planning process in Canadian General Electric is explained. 10 refs.

12648 Mathematical model for long range expansion planning of generation and transmission in electric utility systems. Sawey, R.M.; Zinn, C.D. (Gov Energy Advis Counc, Austin, Tex). *IEEE Trans. Power Appar. Syst.;* **PAS-96**: No. 2, 657-666(1977).

This paper provides a mathematical model (linear mixed integer program) for the problem of selecting an expansion plan over a planning horizon for an electric utility system. The objective function that is chosen is the minimization of the net present value of the capital investment cost associated with the construction of power plants and transmission lines plus the operating costs of the system. The restrictions associated with the problem are the requirement to satisfy the forecasted demands of the systems for electrical energy plus the physical restrictions that result from having limited capital resources and plant site limitations. The model provides construction expansion schedules for power plants and transmission lines (i.e. what capacity to build, where the additional capacity is to be located, and when it is to be completed). Additionally, an approximate operating schedule for plants and transmission lines is provided. An application of the modeling technique to a regional electrical utility system illustrating the formulation methods and the results that can be obtained is given. A discussion of the paper is appended. 17 refs.

12649 Energy crisis and you. Gilson, P.D. (FEA, Reg V. Chicago, Ill). *IEEE Trans. Ind. Appl.;* **IA-13**: No. 3, 195-199(1977).

The national energy industry, and in particular the electric utility industry, is experiencing a serious financial crisis resulting from rising costs of generator fuels and deteriorating load factors. New market possibilities are related, utility problems and pricing are described, and current and future trends in electric generating fuels and national energy conservation legislation are summarized.

12650 Electric rates: a user's view. Fleming, P.A. (Jones, Day, Reavis and Pogue, Washington, DC). pp 137-148 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

New developments in electric rate regulations are analyzed from the user's (or public) point of view. Principles of accountability and practicality are found to be more useful bases for ratemaking than marginal cost pricing. There is already agreement that adequate supplies of efficiently generated and distributed electricity priced to cover the cost of service is acceptable to most users and suppliers.

Agreement also extends to efficient end use and the desirability of a healthy utility industry. Residential users, who place greatest emphasis on the process of ratemaking, need to have representatives who can understand and monitor the principles of ratemaking for them. This understanding provides vital links between the public, a regulated industry, and the regulator. An overview is given of the present role of the Federal government and the controversy over marginal cost pricing to illustrate the need for the criteria of accountability and practicality. (DCK)

12651 Electric utilities in the energy future: load management, electric power rates, and the public interest. Perry, H.F. (Federal Energy Administration, Washington, DC). pp 149-157 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

The future energy role of electricity, as seen from the regulator's view, depends on the utility industry's ability to consume primary energy more efficiently when generating power. Information gained from cost/benefit analyses supports utility load management as a conservation option that is beneficial to users, suppliers, and environmentalists alike. The Federal Energy Administration (FEA) has promoted load management by participating in state and local hearings as an intervenor, encouraging cooperative conservation efforts, and providing financial support to demonstrate its cost effectiveness. Although more information could reduce remaining uncertainties, many utilities are pursuing the already-demonstrated benefits of load management. For those who view the risks as too high, the FEA must provide support for initiatives and information obtained from the Electric Power Research Institute's studies. A proposal is outlined for a year-long program to implement load management transitions. (DCK)

12652 Conway decision and its impact on State—Federal regulatory issues. Cooke, C.E. (Federal Power Commission, Washington, DC). pp 158-165 of In Energy users law 1977. Buck, L.E. (ed.). Washington, DC; Government Institutes, Inc. (1977).

From Energy users law seminar; Washington, DC, USA (27 Jan 1977).

See CONF-770147—.

Circumstances and implications of the recent Supreme Court decision on the Conway case are summarized in relation to the potential effect on wholesale electric rates and the ratemaking role of the Federal Power Commission (FPC). The Court ruled that the FPC has the power to compare and alter differences between jurisdictional and non-jurisdictional rates and must consider cases when there is evidence of discrimination. Since no procedure was set by the Court, the Commission issued a proposed policy statement to the effect that any interested person may initiate an allegation of discrimination and the utility will bear the burden of proof. The Commission must determine if the allegations are sufficiently grounded and if the utility has made a satisfactory response. Problems are foreseen in cases where comparable retail rates are not available and where there is too much uncertainty over the Commission's obligation. Solutions could come from ceding the Commission's jurisdiction over wholesale rates to the states or they could lead to a standardization among the states. (DCK)

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 12274

12653 Comparing coal and nuclear generating costs. Rudasill, C.L. (Electric Power Research Inst., Palo Alto, CA). *EPRI J.;* **2**: No. 8, 14-17(Oct 1977).

EPRI reviewed and analyzed the costs of producing electricity from coal and from nuclear power stations, using available technology with current safety and environmental regulations in six regions of the U.S. The general objectives of the study were to understand the principal parameters that affect the cost of coal and nuclear generation; identify uncertainty ranges in estimates of the costs; provide a consistent set of cost estimates for generation that can be useful in making general appraisals; and establish base cost estimates that can be updated as improved data become available. Overall results show that coal or nuclear generation can be economically viable in all regions; nuclear generation shows an average cost advantage over coal in all regions; average cost positions of coal and nuclear are closer together in the western USA, reflecting the generally lower cost of coal; and a new baseload generating technology must achieve 30-year-levelized total busbar costs of 35 to 45 mills/kWh in 1976 dollars to compete with existing technology on an economic basis. (MCW)

12654 Electric power generation: planning for investments. *Energie;* **29**: No. 6, 161-165(Jun 1977). (In German).

Conclusions reached offer a meeting of coal mining representatives and planners for power generation in the Federal Republic of Germany dealing with the prospective development of power generation are summaried. It was concluded that nuclear power plants should be built no more than absolutely necessary while the priority should be given to thermal power plants.

12655 Power generation according to energy sources in the EC. *VIK (Ver. Ind. Kraftwirtsch.) Mitt.;* No. 3, 52(Jun 1977). (In German).

12656 Statistical utility theory for comparison of nuclear versus fossil power plant alternatives. Garribba, S.; Ovi, A. (Cent Studi Nucl Enrico Fermi, Politec di Milano, Italy). *Nucl. Technol.;* **34**: No. 1, 18-37(Jun 1977).

A statistical formulation of utility theory is developed for decision problems concerned with the choice among alternative strategies in electric energy production. Four alternatives are considered: nuclear power, fossil power, solar energy, and conservation policy. Attention is focused on a public electric utility thought of as a rational decision maker. A framework for decisions is then suggested where the admissible strategies and their possible consequences represent the information available to the decision maker.

12657 Principal characteristics of the French electricity balance in 1976 and the dominant aspects of its evolution during the past three years. Laigroz, J. (Electr de Fr). *Rev. Energ.;* **28**: No. 295, 373-380(1977). (In French).

This article sums up the evolution of the French electricity industry since the price of petroleum increased fourfold three years ago. The process of once again making optimum use of the French power stations is a long range operation. Hardly the first third of this process has been achieved, while the second stage which is now being undertaken appears to be headed for difficulties.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

12658 Planning for energy control centres in India. Pai, M.A. *URJA;* **1**: No. 6, 17-19(Jun 1977).

Five regional power grids are being planned in India to be operational by the end of the decade and eventually a national grid will be established. The installed capacity is presently 20,000 MW and is expected to go to 50,000 MW in the early 1980s. The control and dispatch of this power will call for well planned load dispatch centers. The status of the present energy control centers in India is summarized. (MCW)

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 12800

12659 Analysis of energy input at a hospital. Flaschar, W.; Gossenberger, M.; Markgraf, E. *Brennst.-Waerme-Kraft;* **29**: No. 6, 239-243(Jun 1977). (In German).

For the analysis of the electrical energy consumption, characteristic lines of the input were determined for the whole hospital, for the individual operational sections, and for the largest consumer. They were also used for the daily average of electricity consumption of individual consumers. The evaluation of the operational statistics gave the rate of electricity consumption of previous years. The heat consumption was distributed by approximation over the various consumer group and operational purposes, respectively. In addition, the factors influencing electricity and heat requirements were analysed. 5 figs., 4 tables.

12660 Toward a better understanding of energy consumption. II. Factor analysis: a new approach to energy demand. Charpentier, J.P.; Beaujean, J.M. (IIASA, Laxenburg, Austria). *Energy (Oxford);* **1**: No. 4, 413-428(Dec 1976).

The relationship between energy consumption and lifestyle standards is not yet fully understood. Major studies in this field had failed to consider other variables than the gross national product. This article attempts a better understanding of the complex interface of lifestyle and energy consumption. Factor analyses, to quantify the relation between energy use and economic development, have been performed for 35 developed countries and for 15 OECD countries. The authors state that their measures of the relation between degrees of development and energy consumption may prove to be of more general applicability for forecasting than the widely used correlation between per capita energy consumption and per capita GNP. 3 refs.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 12578, 12579

SOLAR

REFER ALSO TO CITATION(S) 11926, 11927, 12656, 12719

12661 Calculations of energy use and cost in a national program investing $100 billion in solar heating systems. Kriebel, D. St. Louis; Washington University (1976). 5p. (NP—22481).

An estimate is made of the potential impact of the investment of $100 billion in single-family dwellings and commercial solar space heaters on the amount of energy used and on the cost of heat to consumers. The basic approach used was that in 1980 the $100 billion would be loaned by the U.S. government to homeowners and commercial establishments on an interest-free basis. In return, the latter would pay each year, for a ten-year period, the amount of money saved in fuel costs by using solar energy into a rotating fund to be used to pay for further solar installations. At the end of ten years all of the solar heating systems would still be saving fuel costs and this money would be returned to the government, in subsequent annual payments, until all of the original $100 billion is recovered. Thus, the energy users would be assured that there would be no increase in their present heating bills, and the nation would reduce its energy consumption by the amount supplied by the newly installed solar heaters. The calculations were based on a feasibility model of a solar space heating system developed by the Center for the Biology of Natural Systems. The southern U.S. was not included.

GEOTHERMAL

REFER ALSO TO CITATION(S) 12027, 12037, 12055

OTHER

REFER ALSO TO CITATION(S) 12073

12662 Potential for solar and wind electric power generation. New York; Scientists' Institute for Public Information (1976). 53p. (CONF-760260—).

From Congressional seminar on the potential for solar and wind electric power generation; Washington, DC, USA (9 Feb 1976).

Representative Richard L. Ottinger, the moderator of the seminar, initially stated that "if solar energy is to attain commercial status by the year 2000, solar research and development should be funded at a level closer to nuclear research as it is funded today." Representing the Scientists' Institute for Public Information was Allan McGowan. Speakers following Mr. McGowan's brief remarks were Frank Eldridge, Mitre Corporation; Joseph Lindmayer, Solarex Corporation; Piet Bos, EPRI; Ron Larson, Georgia Institute of Technology; Will Smith, Science and Technology Committee; and Dan Ahearne, consultant to Congressman Harold Runnels and the office of Technology Assessment. (MCW)

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

12663 (AEOI—26) **Study of some recent advances in the concept and design of MHD generators.** Vakilian, M. (Atomic Energy Organization of Iran, Teheran. Nuclear Research Centre). Feb 1976. 19p. (NRC—76-20). Dep. NTIS (US Sales Only), PC A02/MF A01.

Direct conversion of energy using a high temperature working fluid makes Magnetohydrodynamics (MHD) power plants potentially much more efficient than steam power stations. The study indicates an overall efficiency of 50% to 60%. This compares with most modern fossil-fuel plants at 40% efficiency. Advances in design and construction of experimental and commercial MHD plants developed in various countries are presented. Environmental effects and advantages of the MHD power plants over the more conventional fossil and nuclear plants are discussed.

12664 Heat transfer problems associated with an MHD power generation system--an overview. Postlethwaite, A.W.; Sluyter, M.M. (ERDA, MHD Div, Fossil Energy, Washington, DC). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-62, 1-9(1977).

The primary system being considered by ERDA is an open-cycle MHD/steam cycle power loop. Critical thermal problems impact the system due to hot ionized plasma, seed injection, slag deposition and high temperature air heaters. MHD power generation has entered the development phase and commercial operation can be achieved by existing materials and techniques. 23 refs.

PERFORMANCE AND TESTING

12665 Influence of finite electrode segmentation on the electrical performances of the Faraday MHD generator. Dogaru, I. (Res and Des Inst for Thermoenergetic Equip, Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 163-170(Apr-Jun 1977).

The electromagnetic field in the conversion duct and the electric performances of the Faraday MHD generator are determined taking into account both the Hall effect and the finite electrode segmentation.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 12664

DUCT ENGINEERING AND FLUID DYNAMICS

12666 Optimum seeding for various combustion systems in open-cycle MHD generators. Hussain, S.Q.; Chandra, A.; Kaushik, S.C.; Sharma, R.P.; Sawhney, B.K. (Indian Inst of Technol, New Delhi). *J. Inst. Eng. (India), Chem. Eng. Div.;* **57**: 112-116(Jun 1977).

The electrical conductivity of the various seeded combustion products systems (Oxy-methane, air-methane and coal burnt in air/oxygen) with temperature and seeding ratio has been investigated theoretically, and the optimum seeding ratio, to obtain maximum conductivity, is evaluated for these systems. The conductivities are high enough to be used for open cycle MHD generators. 13 refs.

12667 Influence of the insulation on the electric characteristics of the MHD generator. Simionescu, G. (Thermoenergetic Equip Res and Des Inst, Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 171-180(Apr-Jun 1977).

A new method for the study of the electric characteristics of a Faraday MHD generator is presented. These characteristics are determined taking into account the electric insulation both between the electrodes and between the combustion chamber and diffuser. The duct is presumed perfectly isolated versus the ground, with a constant cross-sectional area and infinitely segmented electrodes. The method can be also applied to the study of a duct with finite segmented electrodes.

12668 Theory of the radial field vortex MHD generator with an annular channel. Eliseev, B.V.; Imanov, A.B.; Mkrtychan, K.N. *Magnetohydrodynamics (USSR) (Engl. Transl.);* **12**: No. 1, 79-83(1976).

The retardation of a conducting fluid in the annular channel of a vortex MHD generator with a radial magnetic field is considered. The problem is solved by the method of successive approximations using a computer. Analysis of the results gives the condition under which the action of the centrifugal force is sufficient to suppress the transverse vortices in the channel and a smooth reduction of the azimuthal velocity component is possible, i.e., electric power is produced by retardation of the flow. 5 refs.

12669 Electromagnetic processes in an annular channel with finite magnetic reynolds numbers. Vitkovskii, I.V.; Laurent'ev, I.V. *Magnetohydrodynamics (USSR) (Engl. Transl.);* **12**: No. 1, 83-87(1976).

The flow of a conducting fluid in an annular channel in a ferromagnetic field is analyzed. It is shown that the nature of magnetic field falloff outside the magnet is the decisive factor in the calculation of electromagnetic losses in a channel for high magnetic Reynolds numbers. Experiments on a model with an annular channel show good agreement between theory and experiment. 4 refs.

12670 Experimental study on heat transfer in a MHD channel of open type. Kirillov, V.V.; Reshetov, E.P.; Semenov, V.D. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *Teplofiz. Vys. Temp.;* **13**: No. 3, 634-643(May 1975). (In Russian).

The results of an experimental investigation into heat transfer in a flow of partly dissociated gas are presented. The investigation was carried out under conditions corresponding to the operation of an open-cycle MHD generator. The experiments were conducted with a flow of plasma comprising combustion products (Tsub(emax)=2600°K) together with potassium or cesium salts as ionizing additive. The experiments embraced the following range of defining criteria salts as ionizing additive. The experiments embraced the following range of defining criteria $1.3x10^4 <= Resub(chi) <= 2.4x10^4$, $0.55 <= Prsub(e) <= 0.8$; $0.09 <= hsub(w)/hsub(e) <= 0.67$. The results are interpreted on the basis of a theoretical model. Comparison is drawn with the results of other authors. The influence of a number of factors specific to heat transfer in MHD generators is considered.

THERMOELECTRIC GENERATORS

DESIGN AND DEVELOPMENT

12671 Operating ranges of thermoelectric devices. Tomescu, F.M.G. (Polytech Inst of Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 227-232(Apr-Jun 1977).

An analysis of the operating ranges of thermoelectric devices such as a generator, refrigerator, heat pump or heater is given. Different operating ranges and optimum operating conditions within these ranges may be reached by controlling the current flowing through the device.

MATERIALS, COMPONENTS, AND AUXILIARIES

12672 Thermoelectric properties of materials with nonstandard conduction mechanisms. Golikova, O.A. (A.F. Ioffe Physicotech Inst, Acad of Sci of the USSR, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **8**: No. 12, 1543-1545(Jun 1975).

An analysis is made of the thermoelectric properties of semiconductors with polaron and impurity hopping conduction mechanisms and of materials with complex boron-based crystal lattices. It is shown that boron-based materials are most promising for thermoelectric energy conversion in the range 1000-1800°K. Ways of increasing their efficiency are discussed. 10 refs.

FUEL CELLS

12673 Fuel cells: a sleeper in the energy race. Aronson, R.B. *Mach. Des.;* **49**: No. 4, 20-22, 24(24 Feb 1977).

The fuel cell may one day be a serious competitor to large nuclear or fossil-fuel power plants. But, for now, fuel cell power generation has its greatest appeal as an auxiliary unit in conventional power plants or for on-site power generation in a single factory or apartment. Advantages of the fuel cell include low pollutant levels, virtually no size restrictions, high efficiency and multi-fuel capability. Present research suggests the possibility of using fuel oil and ultimately residual oil and coal gas as fuel cell fuels.

DESIGN AND DEVELOPMENT

12674 (SAND—75-0074) **Magma fuel cell.** Haaland, D.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1975. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

A high temperature, solid-electrolyte fuel cell is described which uses molten rock having oxidizable constituents as a fuel. The principles of this magma fuel cell have been successfully demonstrated and power densities of 88 W/m^2 have been achieved. If power densities can be substantially increased, the magma fuel cell may find numerous applications in magma tap projects to increase the efficiency of energy extraction from magma sources or may provide the energy necessary for the electrochemical protection of the heat exchanger materials placed in the corrosive magma environment.

12675 Hydrazine/oxygen fuel cell for small power. Kohlmueller, H.; Naschwitz, W. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,445,380/A/. 8 Apr 1976. 13p. (In German).

A hydrazine oxygen fuel cell contains a porous asbestos membrane serving as diffusion barrier between the hydrazine and oxygen electrodes, which makes sufficient water transport to the oxygen electrode possible and reduces chemical short circuit currents to a sufficient extent. Ion exchange material is stored in the pores of the asbestos membrane.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 12908

12676 Equipment for the control of the electrolyte concentration of fuel cell batteries. Jaeger, P. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,519,098/A/. 4 Nov 1976. 5p. (In German).

In the equipment invented, the density difference between the electrolyte liquid and the depleted reaction water is used to maintain the concentration of the aqueous electrolyte of a H_2 fuel cell via the hydrostatic pressure. The equipment works automatically and without consuming high-value energy.

12677 Method for the production of porous fuel cell electrodes containing a hydrophilic and a hydrophobic layer. Binder, H.; Kuhn, W.; Linder, W.; Sandstede, G. (to Battelle-Institut e.V., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 1,671,713/B/. 29 Jul 1976. 3p. (In German).

The patent claims relate to the use of a ready-manufactured porous and hydrophobic polytetra-fluoroethylene layer, and on the process of joining it to a hydrophil electro-chemically active layer. The joining process is based on the interposition of a thin layer of powder, consisting, for the most part, of polymers of the polyethylene, polytetra-fluoroethylene or polytrifluor-chlorethylene groups, and of the hot pressing of the 3 layer electrode at just above the softening point of the polymers. The mixture of pore-forming substances such as powdered coal, soluble salts or joints which can be thermally destroyed are claimed for the intermediate binding layer.

12678 Porous or roughened electrode with an assigned matrix for electrochemical cells with acid electrolytes, especially fuel ceil batteries. Boehm, H.; Fleischmann, R. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.)). German(FRG) Patent 2,417,447/A/. 16 Oct 1975. 15p. (In German).

According to the invention an electrolyte matrix is to be used, which experiences a definite increase in volume by swelling, and fits on to the electrode in such a way that it is closely meshed with it. Matrix materials treated with sulphuric acid are claimed, such as 1) polystyrol, polyethelyne, polyvinyl alcohol, polyvinyl acetate, methyl cellulose or polyester, which are used alone or compounded with silica gel, aluminium oxide or sea sand, and 2) zeolite, silica, aluminium dioxide, titanium dioxide or zirconium dioxide using binding materials.

12679 Method for the separation of reaction water from fuel cells. von Sturm, F.; Kozdon, F. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 1,596,221/C/. 28 Aug 1975. 5p. (In German).

This supplementary patent improves the energy balance of the method described and claimed in the main patent 1496230. It is characterized in that 1) a concentrator is connected in series with an electrolyte cooler in which the necessary contact to take up the reaction water in the form of steam takes place between the aqueous electrolytes and one of the reaction gases, and 2) the reaction gas is passed through a cooler and then through the water separator before introduction into the fuel cell. Further claims concern the continual addition of the consumed reaction gas partly led in circuit, the fine distribution of the electrolytes in the concentrator and the gas flow vertical to the finely distributed, moving electrolytes.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 12592

12680 Financial aspects of compressors. Weissinger, W. *Glastech. Ber.;* **50**: No. 3, 49(1977). (In German).

BUILDINGS

REFER ALSO TO CITATION(S) 12575

12681 Solar-energy conserving. Thomason, H.E. US Patent 4,048,812. 20 Sep 1977. Filed date 17 Feb 1976. 4p.

In order to conserve energy when the thermostat turns air conditioning apparatus on, apparatus is employed to automatically reduce energy input to, and also heat output from, illuminating apparatus in the area being air conditioned. This is feasible because, in many instances, increased illumination from the sun, during daylight hours, renders the need much less for illumination from lamps or artificial luminares. In other instances, turning off a few lamps in each office can avoid blackouts, brownouts, overloading of generators, and burning out of air conditioning apparatus and other electrical appliances.

12682 Radiator arrangement and room temperature. Kuenzel, H.; Mayer, E. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Holzkirchen (Germany, F.R.). Inst. fuer Bauphysik). *Gesund.-Ing.;* **98**: No. 7/8, 199-200(Jul 1977). (In German).

Tentative results of tests concerning temperature distribution and aerodynamic flow in rooms in which the radiators are installed on the external or internal wells are presented. According to these results, installation of the radiators on the internal walls with increased thermal insulation is of advantage since it helps to save about 15% heating energy without having a negative effect on the temperature in the room. The result is of special interest for the reconstruction of old buildings as installation on internal walls is less expensive. Thus costs can be saved.

12683 Physics relating to construction and to thermal insulation. Cammerer, W.F. (Forschungsinstitut fuer Waermeschutz e.V., Grae-

felfing (Germany, F.R.)). *Elektrowaerme Int., Ed. A;* **35**: No. 4, 195-198(Jul 1977). (In German).

From 23. plastics colloquium on energy saving by means of better thermal insulation with foamed plastics; Wuerzburg, Germany, F.R. (15 Dec 1976).

If building failures of modern building structures are to be prevented, attention has to be paid, already at the planning stage, to the laws of physics relating to construction and dealing with thermal insulation, heat capacity and climate-dependent protection against moisture, particularly in the case of multi-layer types of buildings. This is eypecially important for the redevelopment of old buildings. Construction standards and regulations issued by the Construction Superversion Authority have to be taken into consideration.

12684 Considerations regarding modern district cooling plants. Piemonte, C.; Scalvi, G. (Politec di Milano, Italy). *Termotecnica (Milan);* **31**: No. 6, 286-294(Jun 1977). (In Italian).

There are only few examples of district cooling plants today, but they are going to multiply rapidly in the near future. This paper, after a general look at the problem, suggests a solution based on total energy systems, utilizing open-cycle gas turbines and diesels as prime movers, and estimates the performances, which can be obtained by means of the suggested plans.

12685 Heat pumps with thermal drive. Herrmann, H. German(FRG) Patent 2,543,569/A/. 7 Apr 1977. 5p. (In German).

A system is described in which a heat pump (in particular a compressor heat pump with I.C.-engine drive) is coupled with additional heat-converting aggregates which supply the heat to the media to be heated. The aggregates are: Evaporator, super-heater or heater of a thermal engine, boiling apparatus or evaporator of absorber heat pumps, steam generator of steam jet heat pumps and heat exchangers for the medium or the media to be heated. The invention aims at a higher rate of waste heat utilization.

12686 District heating channel, especially for hot water pipelines. Lundbohm, L. (to Nyby Bruk AB, Nybybruk (Sweden)). German(FRG) Patent 2,352,623/C/. 31 Mar 1977. 3p. (In German).

The invention aims at improving a district heating channel with insulated pipes in such a way that a simple assembly enables quick dehumidification of the insulation. In the case of ingress of water, too, the heat insulation is to function again quickly. The pipe insulation is described.

12687 Method for transferring heat and cold and heat pump for realising it. Burger, M.R.; Gagel, E.; Kalmovicz, R.; Prechtl, A. German(FRG) Patent 2,542,728/A/. 31 Mar 1977. 27p. (In German).

The method for transferring heat and cold consists in connecting 2 separate circuits with liquid or gaseous media via heat exchangers with a heat pump in between. The cold circuit is operated constantly and steadily. The two separate circuits are caused to function as heat exchangers for alternative heating or cooling with the evaporator and the condenser. The claim refers to a number of system connections and to the technical construction of duct-leading of the media.

12688 Heat pump with storage. Kirn, H. German(FRG) Patent 2,540,143/A/. 10 Mar 1977. 11p. (In German).

A method to control a solar energy or heat pump heating system with a heat storage is described. According to the method, the effective value of the heat stored is compared at any time of the year with a nominal value according to the season. If the effective value is too low, it is raised to its rated value by increased heating. The rated value is given by a seasonal component formed as motor potentiometer. The storage temperature is measured with a resistance depending on temperature and evaluated via bridge - resp. voltage distributor - connections. A heat pump, the subcooling heat of which is led to the heat carrier fluid of the solar collector or external air heat exchanger, is used as additional heating. The temperature of the heat transporting liquid is controlled and influenced by means of a control valve, thus becoming higher than the storage temperature.

12689 Possibilities of practical heating cost savings and improvement of living climates. Grunau, B. (Institut fuer Baustoff-Forschung, Erftstadt (Germany, F.R.)). *Gesund.-Ing.;* **98**: No. 3, 44-51(Mar 1977). (In German).

15 figs.; 5 tabs.

In view of increasing energy prices the possibilities of obtaining heat cost savings while simultaneously improving living climates are discussed. Among other things the following technical building measures are mentioned: the dampness of walls and its influence on heat flow from interior to exterior; improvment of heat insulation, impregnation of the walls; water repelling facade paint. The techniques of wall protection against rain water are at a stage which allow almost every wall to be kept dry. According to experience up-to-date, it can be expected that energy cost savings and improvement of living climate are obtainable within a period of from 15 to 20 years on account of technical building measures.

12690 Soundproofing and thermally insulating building boards. Durand, H.W.; Bunker, R.D. (to Grain Processing Corp., Muscatine, Iowa (USA)). German(FRG) Patent 1,901,635/B/. 10 Feb 1977. 4p. (In German).

Building boards of fibrous material are dealt with where maleic acid modified starch is used as binder. Furthermore, up to 20% clay can be added as filler. The methods for the production of the boards are explained.

12691 Difficult planning and fulfillment of quotas. The energy consumption on the sector households and small consumers in Czechoslovakia up to 1980. Peer, V.A. *Oel;* **15**: No. 2, 46-48(Feb 1977). (In German).

5 tabs.

The article is concerned with a report from the 'Ministry of Fuel and Power' Prague, on the future energy requirement of private households and the municipal sector. It is shown that it is not simple, even in a country with detailed planning in a strictly planned economy, to reconcile the different interests of energy suppliers and consumers. In the years 1975 - 1980, structural changes are predicted regarding the composition of the energy sources in favor of 'noble energy' (i.e. away from coal as an energy source). The reason is an improvement in comfort. An increase of energy consumption is caused by the increase in the number of flats in accordance with the 6th Five Year Plan. According to the Ministry's publication there may still be gaps in supply in supplying private households.

12692 Building heating on a building exterior wall. Gartner, K. (to Gartner (J.) und Co., Gundelfingen (Germany, F.R.)). German(FRG) Patent 2,132,921/C/. 27 Jan 1977. 6p. (In German).

The invention concerns building heating on an exterior building wall with a closed heating system circuit consisting of a hollow wall, floor and ceiling elements and vertical support post, which displays square shaped cross-section. According to invention specifications the hollow support posts are joined to the heating water circuit along with the floor elements arranged at floor level in the exterior wall, which are constructed as swell canals and the ceiling elements on the exterior wall arranged at ceiling level and constructed as support canals. The hollow support post, swell canals, and support canals are separated from the rest of the wall parts through insulation.

12693 Energy saving supply installation for air conditioning and heating of indoor swimming pools. (to Pflueger Apparatebau G.m.b.H. und Co. K.G., Herne (Germany, F.R.)). German(FRG) Patent 2,471,082/C/. 20 Jan 1977. 8p. (In German).

The invention concerns an air conditioning system, which as a supply installation is able to heat all room tracts of an interior swimming pool with differentiating heat levels, through the principle of heat recovery by means of using a heat pump in such a manner that a one-sided disturbance of a room tract temperature through flexible and hasty regulation is prevented. Thus, individual heat quantities are optimally distributed dependent upon seasonal deviations and use requirements of the individual user and according to their particular priorities at, if possible, lower pre-run-temperatures of the water circuit and the favorable efficiency figures for the heat pump resulting thereby.

12694 Device for heat supply in buildings. Peter, E.; Scharf, F.; Mendler, W. (to Bosch (R.) G.m.b.H., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,528,429/A/. 20 Jan 1977. 8p. (In German).

An air heat pump is described which the evaporator and ventilator are arranged under the roof of the building to be heated. The outside air is led to the evaporator through hollow spaces formed by shellings under the roof and on the outside wall. The shellings consist of heat isolating material. For more effective utilization of solar heat, a layer permeable to light but not permeable to air is arranged above the roof at some distance to it. For the same purpose, the shelling on the outside wall also consists of material permeable to light. This can be protected from solar radiation by roll shutters, Venetian blinds etc.

12695 Heat pumps with thermal drive. Herrmann, H. German(FRG) Patent 2,528,736/A/. 13 Jan 1977. 7p. (In German).

The claim refers to a system for the highest possible utilization of thermal driving energy for compressor, absorber and steam jet heat pumps for the purpose of returning waste heat. Design and functioning of the heat exchangers, which convey the heat coming from the driving system part to the medium to be heated or to the medium in the loop, are described.

12696 Climatic engineering economy. Cost/benefit analysis on the problems of air conditioning. A case study. Pt. 1. Aim, subject and methods of investigation. Brendel, T.; Guettler, G. *Gesund.-Ing.;* **98**: No. 1/2, 25-34(Jan 1977). (In German).

Rising energy prices, high building costs, and attacks from various sides, in particular from organizations of the state and industrial medicine, have brought the question of whether working places in a moderate climate, like that of the FRG, ought to be air-

conditioned at all, is discussed. This article is to contribute to making the discussion more objective, i.e. on the basis of an overall survey of the system being in question and of all influencing parameters which are quantifiable. On the basis of the presented case study results, it becomes apparent that the question from the point of view of profitability aspects can be answered in a concrete individual case with satisfactory accuracy with the aid of the methods introduced.

12697 Possibilities of energy conservation in new buildings. Adamson, B. (Lunds Tek Hogsk, Swed). *VVS - Tidskr. Varme, Vent., Sanit.;* **48**: No. 1, 27-31(Jan 1977). (In Swedish).

The various measures which can efficiently decrease energy consumption in new buildings are discussed and demonstrated by the example of an office room by calculating the resulting energy economy. Finally, optimization of energy conservation measures is dealt with.

12698 Investitions- und Betriebskosten von Klimaanlagen mit Waermerueckgewinnung. Beispiel: Universitaet Dortmund 1974/1976. (Investment and operation costs of air-conditioning systems with heat recovery. Example: University of Dortmund 1974/1976). Bunse, F. (LTG Lufttechnische G.m.b.H., Stuttgart (Germany, F.R.)). Karlsruhe, Germany, F.R.; Mueller (1977). 148p. (In German).

The economic advantages of heat recovery devices in ventilation and air-condition systems are undisputed. For judging the profitability of an air-condition system, the first plan of the system is of great importance. Air-condition systems for building with units used at different times must allow a variable operation so that they can meet the differing quantitative demands in the course of a year. The system comparison is explained with the example of a central auditorium building with 8 auditoria. The cost situation is discussed for several types of operation (with/without heat recovery, with/without recuperator). Extensive indicating tables are presented.

12399 Heating in the year 2000. Lehmann, G. (Soc des Ing Civ de Fr). *Rev. Energ.;* **28**: No. 295, 359-364(1977). (In French).

The purpose of the article is to pose questions in the hope to call forth answers. It is recalled that energy consumption in the residential and tertiary sectors amount to 39% of the total consumption, before industry (38%), transport (21%), and agriculture (2%). The main systems of heating are recalled and the inforamtion required to study the heating in the year 2000 is indicated.

12700 Corner joint for plastic-foam profiles, especially in insulated window and door designs. Goetschel, H.; Kern, H.; Botzenhardt, H. (to Wieland-Werke A.G., Ulm (Germany, F.R.)). German(FRG) Patent 2,453,023/C/. 30 Dec 1976. 7p. (In German).

The invention relates to a corner joint for multi-layer sections filled with plastic foam, especially in thermally insulated window and door designs, which uses corner angles whose legs are fitted into recesses of the thermal insulation foam and fixed in place. In the invention, the legs of the corner angles are engaged in circular bores in the thermal insulation foam and are guided in segments of the section shells, with the segments abutting against the bores and having the same radii and the same center points as the bores. The corner angles are held in place by the familiar techniques of glueing, stamping, bolting and screwing or by a combination of these measures.

12701 Heat exchangers to be embedded in the ground. Feist, A. German(FRG) Patent 2,525,480/A/. 23 Dec 1976. 6p. (In German).

The claim refers to a heat exchanger designed for a heat pump. In contrast to the common, space-covering tube systems, this heat exchanger needs less space resp. has a higher efficiency. The heat exchanger is made of two rectangular foils, one on top of the other, welded internally and at the rims with joints, resulting in ducts arranged meander-like for the flow of the heat transfer medium.

12702 Method and device for the heating of waters by means of heat pumps. Friedel, W. German(FRG) Patent 2,324,208/C/. 9 Dec 1976. 3p. (In German).

The claim refers to a method for the heating of waters by means of a heat pump with the purpose of prolonging the swimming season. A heated area of water is separated horizontally and vertically by foil webs or plates (mounted on floating bodies). The heat pump extracts thermal energy from the non-heated water area and conducts this energy to the areas to be heated.

12703 Corrosion in cold and warm water systems. Report on the activities of the project group 5 in the research and development programmes 'Corrosion and protection against corrosion'. Schwenk, W. (Mannesmann-Forschungsinstitut G.m.b.H., Duisburg (Germany, F.R.)). *Gas- Wasserfach, Wasser - Abwasser;* **117**: No. 12, 565-567(Dec 1976). (In German).

With reference to the R and D programme 'Corrosion and protection against corrosion', supervised by DECHEMA and promoted by the BMFT (Federal Ministry for Research and Technology), the progress of the project group 5 is reported on. Laboratory tests, field tests with drinking water, kinetic investigations with unalloyed and galvanized steel, hot water supply systems and heating, de-ionized water, and aluminium materials find a special mention.

12704 Heat accumulators for heat pumps. Schweikhardt, F. German(FRG) Patent 2,619,504/A/. 18 Nov 1976. 14p. (In German).

A latent accumulator is described, containing a storage substance in the form of salt or a salt compound which, due to certain properties, is capable of absorbing and emitting heat by means of a heat pump. Simultaneously, the accumulator has the properties of a solar collector, whose surface configuration is adaptable to architectural requirements. The accumulator is thermally insulated. If used as solar collector, at least the sunward side of the casing is made of a material with a high degree of thermal conductivity. Means are provided for voluntarily delaying and launching the exothermal crystallization of the storage substance according to a predetermined program.

12705 Insulation constructional part with plate-shaped insulating layer for roof and wall construction. Haacke, W. German(FRG) Patent 2,514,259/A/. 21 Oct 1976. 13p. (In German).

The invention concerns an insulating constructional part in a plate shaped insulating layer to be laid behind roof and wall constructions, which are provided with ventilation channels. The insulating layer consists of foam plastics or mineral fibers, particularly stone wool, asbestos fibers and expanded minerals. The insulating layer is provided on the inside with aluminium foil as damp blocking layer, which is lacquered. On the outside the insulating layer has a waterproof layer of fleecy material. Spacers are provided on this side to form ventilation channels, whose supporting arms project into the insulating layer.

12706 Control arrangement for carrying out economic operation of a heat pump arrangement for air conditioning. (to Brandi Ingenieure G.m.b.H., Frechen (Germany, F.R.)). German(FRG) Patent 2,515,206/A/. 21 Oct 1976. 9p. (In German).

The invention concerns a control arrangement for heat pump plants, which use waste heat sources of different temperatures, which may be high at times. The heat pump, compressor, evaporator and condenser are part of the heat pump plant. A cold water circuit is part of the condenser. In order to be able to operate the plant economically, a control valve for the evaporator is provided in the bypass of the cold water circuit, according to the invention, which controls the waste heat exchange, in relationship to the inlet temperature, to the evaporator. Another valve of small flow resistance is connected in parallel with the control valve, which can be controlled in relationship with the heat requirement. The above-mentioned valves can be controlled by computer depending on the ambient air enthalpy and the cold or heat requirement values of the building.

12707 Constructional part, particularly for a room wall, with increased possibility of heat storage. Haenny, J. (to Sulzer Bros. Ltd., Winterthur (Switzerland)). German(FRG) Patent 2,503,506/B/. 7 Oct 1976. 4p. (In German).

The invention concerns a constructional part, particularly for room walls, with increased possibility of heat storage. It consists of several layers arranged sequentially in the direction of heat flow, which consist alternately of heat resisting and heat storage material. The heat storage layer contains a liquid, which is prevented from evaporating and is contained by physical material to prevent leakage. The liquid is held, for example, by capillary forces in a porous material of finely divided type.

12708 Heat storage for oil-fired equipment. Koetting, F. German(FRG) Patent 2,457,529/B/. 30 Sep 1976. 2p. (In German).

The invention concerns a heat storage unit for oil-fired equipment, particularly oil-fired central heating boilers, which can be inserted in the heating boiler at a later stage. It consists of welded high grade steel sheets, which form a hollow space closed on all sides, which is filled with gravel. A projecting point is arranged coaxial with the combustion tube of the oil burner, which divides the flame more symmetrically between the combustion channels arranged around this point. Thus the heat store content is heated without extra energy requirement by the better use of the parts of the heat which are otherwise lost to the chimney and it gives up its energy after shutdown of the burner.

12709 Equipment for thermal insulation. Gassner, E. German(FRG) Patent 2,608,728/A/. 16 Sep 1976. 15p. (In German).

A device for thermal insulation in the form of sliding or rolling blinds for windows, doors and glass surfaces is described. The device consists of a plate with a coated surface. Moltoprene, polyurethane, polystyrene or plastic foam are thought of as materials for the plate or the coating.

12710 Heat power and surface temperature of room radiators. Schlapmann, D. (Stuttgart Univ. (TH) (Germany, F.R.). Fachgebiet

Heizung-Lueftung-Klimatechnik). *HLH, Z. Heiz., Lueftung, Klim., Haustech.;* **27**: No. 9, 317-321(Sep 1976). (In German).

Efficiency measurements on radiators without additional convection parts are reported on. The characteristic curves of the various test objects depend on the heat carrier flow. This fact becomes particularly apparent in the case of low-down run-on connections and little heat carrier flow. The surface temperatures of the radiators are distributed over the radiator surface practically linearly. The average surface temperature roughly coincides with the surface temperature measured in the radiator's geometrical center. There is a close connection between the surface temperature and the heat capacity for every kind of connection and for all sorts of operating conditions.

12711 Water heating system. Schmidt auf Altenstadt, H. (to Vaillant (J.) K.G., Remscheid (Germany, F.R.)). German(FRG) Patent 2,302,778/B/. 8 Jul 1976. 4p. (In German).

The invention concerns a water heating system with heat source, radiators, pump, connecting lines and expansion vessel. To ensure relief of an excess pressure over 2.5 atmospheric excess pressure and to prevent the formation of a vacuum due to the cooling-down (and contraction) of the flow volume of the heating plant - which would cause gas to be sucked into the line network -, a double non-return valve is provided between the expansion vessel and the branching point from the circulation line. In this way, excess pressure can be suppressed, and water can be drawn back into the line network in case of a partial vacuum.

12712 Device for saving energy by utilizing waste heat. Lehnhardt, H. German(FRG) Patent 2,500,370/A/. 8 Jul 1976. 7p. (In German).

A device for the use of the waste heat of heating installations is described. For this purpose a pipe incasement is provided on the exhaust supports of a waste burning plant, through which air is sucked through by a ventilator. This heated air releases its heat to a fluid by means of heat exchange, which is in return led to corresponding heat elements.

12713 Window with extremely high, but basically variable thermal insulation, which can be used for direct space heating. Kley, W. German(FRG) Patent 2,461,716/A/. 8 Jul 1976. 17p. (In German).

A window with extremely good thermal insulation is described. A metallized plastic foil or a metallized glass pane with 75% transmission for visible light and a reflective power of 85% for infrared radiation is inserted between two glass panes. If a plastic foil is used, it will be installed in such a way that it can be rolled up, so that variable thermal insulation and regulation of the light intensity are made possible.

12714 Refrigeration heat recovery installation. Leonard, L.H.; Patnode, M.M. (to Carrier Corp., Syracuse, N.Y. (USA)). German(FRG) Patent 2,538,730/A/. 24 Jun 1976. 35p. (In German).

The invention concerns a refrigeration machine, in which the refrigeration heat is usable for domestic and industrial heating systems. This occurs, according to invention specifications, through the use of a combination of compressor and absorbtion refrigeration machines. The absorbtion aggregate is inserted between the front of the compressor and the condensator. Freon R-11 is used as a refrigeration medium, Texaco URSA oil serves as absorbtion medium, water serves to cool the oil which is heated through the absorbtion of the Freon steam, which flows against the stream through the heat exchanger and heats itself so much in the process that it can be used for heating purposes.

12715 Heat-insulated building with a skeleton construction consisting of profile supports. Hida, N.; Kaiden, M.; Muraoka, N.; Otsubo, H. (to Takenaka Komuten Co. Ltd., Osaka (Japan)). German(FRG) Patent 1,684,982/C/. 16 Jun 1976. 7p. (In German).

A heat-insulated building is described in which the skeleton construction consists of profile supports, the mould consists of corrugated iron, and the heat insulation is on the inner side of the mould. The solution according to the invention achieves a high degree of insulation against external heat by means of a simple, fast, and light construction. A roof plate consisting of corrugated iron is fixed on the lateral mould at a certain distance from the upper mould, thus rising above its upper edge. The recesses in the corrugated iron roof plate are perpendicular to the recesses in the irons of the lateral mould. The air in channel-like interspaces between the waves of the corrugated iron and the insulation material is used for insulation and helps to increase the insulation by the chimney effect developing.

12716 Heat storage in buildings. Borresen, B.A. (Trondheim Univ. (Norway). Institutt for Thermodynamikk). *HLH, Z. Heiz., Lueftung, Klim., Haustech.;* **27**: No. 1, 24-26(Jan 1976). (In German).

In order to simplify the treatment of heat flow problems in buildings, some facts are presented which emerged as a result of the application of the frequency analysis observing the heat storage in walls. This knowledge contributes in particular to a better understanding of the response of room air to dynamic heat loads and to thermal properties of building structures.

12717 Design of indoor swimming pools. Pt. 1. Aeration and ventilation. Heat demand. Circulation of swimming pool water. Krinninger, H. (Fachhochschule Muenchen (Germany, F.R.). Fachbereich Versorgungstechnik). *HLH, Z. Heiz., Lueftung, Klim., Haustech.;* **27**: No. 1, 10-16(Jan 1976). (In German).

Swimming pool engineering has undergone sweeping refinements these last 10 years. Despite extensive clarification of all detail problems, a compilation is missing for the projecting engineer in the field of heating, air conditioning, and building engineering. A summary is given of the main principles for the planning and construction of indoor swimming pools. Aeration and ventilation, heat supply, and the circulation of the swimming pool water are discussed..

12718 Energy saving in air-conditioning and refrigeration. Langeheinecke, K. *Kaelte (Hamburg);* **29**: No. 8, 315-318(1976). (In German).

Lectures held on the occasion of the Hannover Fair within the framework of the EXPOCLIMA Congress 1977 are summarized. Among the subjects dealt with were measures for the conservation of energy in the construction of buildings, air-conditioning plants, heat recovery, thermal accumulators, and reducing peak loads in power supply, solar energy, heat pipes.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 12056, 12548, 12630, 12661

12719 (CONF-770870—1) **Annual Cycle Energy System concept and application.** Moyers, J.C.; Hise, E.C. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 8p. Dep. NTIS, PC A02/MF A01.

From Proceedings of the faculty institute energy conservation) theory and practice; Oak Ridge, TN, USA (1 Aug 1977).

The Annual Cycle Energy System (ACES), under development at ERDA's Oak Ridge National Laboratory, promises to provide space heating, air conditioning, and water heating at a significantly lower expenditure of energy than conventional space conditioning and water heating systems. The ACES embodies heat pumping, thermal storage and, where climate dictates, solar assistance. The concept is described, along with variations in design that permit flexibility to maximize energy conservation or to provide load management capabilities. Installations that exist or are under construction are described and variations that are incorporated to meet specific objectives are discussed.

12720 Energy consumption in private households. Kolar, J. (Tech Univ Muenchen, Ger). *Gas- Wasserfach, Gas-Erdgas;* **118**: No. 6, 241-245(Jun 1977). (In German).

Results of survey in representative cities of Federal Republic of Germany are discussed. Degree of energy utilization is estimated for gas, coal, electricity and district heating appliances. 26 refs.

12721 Evaporative heat meters in practice. Fischer-Hansen, J.P. *Batim. Int.;* **5**: No. 3, 164-171(May-Jun 1977). (In English and French).

The paper considers European experience and the effects on energy consumption from the use of evaporative heat meters in homes served by collective heating systems. 8 refs.

12722 How to heat residential buildings with minimum energy consumption. Eriksson, J.C. (R Inst of Technol, Stockholm, Swed). *Tek. Tidskr.;* **107**: No. 8, 24-27(22 Apr 1977). (In Swedish).

The article shows that energy consumption for heating of residential buildings can be cut down by up to 90%. A heating system consisting of a fuel cell, a heat pump, and solar energy is theoretically most efficient. Electric heat is the most disadvantageous option and causes excessive energy waste.

12723 Bivalent heating with heat pumps. Design and mode of operation. Keller, G. (Bosch (R.) G.m.b.H., Wernau (Germany, F.R.). Geschaeftsbereich Junkers). *Oel- Gasfeuerung;* **22**: No. 2, 71-81(Feb 1977). (In German).

After an introduction to the basic principles of heat pumps, the special characteristics of monovalent/bivalent operation are explained. The mainly economic advantages of a bivalent system (using oil, natural gas and electric storage heaters) are described as the result of an optimization calculation. Finally, operational experience with bivalent parallel heat pump systems is reported, which uses ground water, the soil, and air as heat sources. The additional heating in parallel operation is provided by oil or liquid gas.

12724 Thermal splitter, an energy transformation device for the household. Bachl, H. *Energiewirtsch. Tagesfragen;* **26**: No. 12, 703-711(Dec 1976). (In German).

The thermal splitter is a heat pump which simultaneously works as a refrigerator. The working medium is air, whose heat content is split by the added mechanical energy into heat and cold. Because of the opposing effects of temperature difference on the output, it is necessary to optimize the whole process. The characteristics of open and closed circuits, and a combination of both, all using solar energy, are described. The advantages of the system are explained, using a calculated example of temperature curves and energy conversion of 3 different circuits. A calculated comparison is made between all-electric supply and thermal splitter supply of a 4 person household. Finally there are some instructions on lay-out.

12725 Energy in the household. Comparison of heating costs and energy demand prognosis up to 1985. Luehrmann, W. *Energiewirtsch. Tagesfragen;* **26**: No. 10, 567-579(Oct 1976).

The results of a study by the VEBA AG on the energy consumption of private households are presented. The first part of the investigation deals with a comparison of the costs for heating for natural gas, district heating, fuel oil, coal, and electricity. The second part contains a medium-term prognosis of the energy consumption on the household sector until 1985. In this context, the investigation concerning the costs for heating and statistical data available was taken into consideration.

OFFICE BUILDINGS

12726 Office rooms without radiations when satisfying insulation requirements. Blomqvist, C.; Isfalt, E.; Malmstrom, T.G.; Svensson, A. (KTH, Swed). *VVS - Tidskr. Varme, Vent., Sanit.;* **48**: No. 1, 33-38(Jan 1977). (In Swedish).

It is demonstrated that if building facades and windows could be made as impermeable as required by the new energy conservation standards, office room air conditioning could be performed using simple installations and a very little additional energy for heating and cooling. 3 refs.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

12727 Analysis of energy consumption in hospitals. Flaschar, W.; Gossenberger, M.; Markgraf, E. (Tech Univ, Munich, Ger). *Brennst.-Waerme-Kraft;* **29**: No. 6, 239-243(Jun 1977). (In German with English abstract).

An analysis is made about electrical power consumption in hospitals. A breakdown of the consumption by individual departments is made. A load calculation is demonstrated indicating the possibilities of energy savings.

12728 All-electric clinic in Berus/Saar. Putze, A. *Elektrowaerme Int., Ed. A;* **35**: No. 3, 170-172(May 1977). (In German).

Detailed information is given on the building, the heating, ventilation and air conditioning systems, on other electrical installations such as lighting, weak current systems, kitchen, laundry, incineration, sterilization and desinfection, on power supply and power consumption as well as on the system costs.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 12661

12729 Fuel consumption in industrial buildings. Kirkwood, R.C. (Hulley and Kirkwood, Consult Eng, Glasgow, Scotl). *Build. Serv. Eng.;* **45**: No. 3, 23-31(Jun 1977).

Annual fuel consumptions for seven large factories are compared against calculated requirements to illustrate seasonal thermal efficiencies of 7.7 to 49.7 %. Ineffective and uncontrolled ventilation is shown to be by far the most significant factor leading to fuel consumptions several times the necessary requirements. Fuel savings of 38 to 80 % which have been achieved are illustrated. Fuel savings of 20 to 80 % are shown to be possible in the factories studied, with 35 to 95 % savings possible where heat recovery is provided in addition to other improvements. 7 refs.

12730 Use of heat pumps for heat recovery and for the heating of industrial plants. Eickenhorst, H. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G. (Germany, F.R.)). *Keram. Z.;* **29**: No. 3, 118-120(1977). (In German).

Whenever planning heating and air-conditioning installations, particularly for industrial firms wiht large heat consumers, an investigation of the numerous economic and technical possibilities to recover heat must be demanded. In general, you can start from the following sources of heat: in overground workings as well as in industrial plants: lighting, personnel heat, heat of machines and installations, solar radiation, exhaust air, air humidity. Heat recovery is possible via heat exchangers and heat pumps. The operation of heat pumps and their utilization are discussed.

12731 Heat recovery in supermarkets. Ricken, J.; Schwarz, P. *Linde Rep. Sci. Technol.;* No. 25, 2-15(1977).

The article briefly define the requirements of heat-recovery systems in general, and then focus on the problems and solutions related to the heat recovery in supermarkets in particular. Usable heat sources in supermarkets are pinpointed, and planning guidelines for the use of a heat-recovery plant are given. Various types of heat-recovery facilities are discussed and their costs compared.

12732 Integrated heating and ventilation system for a multipurpose building in an estate for the aged. Dreyer, K. (Hamburgische Electricitaets-Werke A.G. (Germany, F.R.)). *HLH, Z. Heiz., Lueftung, Klim., Haustech.;* **27**: No. 6, 165-167(1976). (In German).

From North German technical meeting 'Energy saving methods in heating and air conditioning'; Kiel, Germany, F.R. (6 Nov 1975).

11 figs.

An integrated heating and ventilation system for a multipurpose building, including swimming bath, within an estate for the aged in Hamburg is described. By using heat pumps, regenerative heat exchangers and air-water heat exchangers heat energy once used is utilized several times, the waste air (swimming bath, central heating, ventilation plant) and cooling water (compressor) are recovered and used for producing hot water and for heating purposes. The heating network works at a system temperature of 45/40°C. In addition, electrically heated storage tanks are available for hot water and heating. The function of the plant is explained using numerous schemes.

TRANSPORTATION

REFER ALSO TO CITATION(S) 12805

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 13187

RAILWAY

12733 (DOT-TST—77-34) Handbook for preservation of local railroad service. Final report. Patton, E.P.; Langley, C.J. Jr. (Tennessee Univ., Knoxville (USA). Transportation Center). Jan 1977. 114p. NTIS.

Throughout the United States, there is an accelerating abandonment of redundant and/or unprofitable light-density railroad lines. This abandonment can be economically harmful to both the shippers and the communities that were previously served. Although greater dependence upon truck transportation is a viable alternative in many cases, other situations indicate that the greatest priority should be attached to preserving some form of local railroad service. The objective of this research was to develop a handbook to assist shippers, local and state governments, and rail planners when their Class I rail service is scheduled for abandonment. Two major options are detailed in the handbook. The first regards innovative procedures which may be used by local groups in attempting to preserve service by the existing Class I carrier. The second approach considers the alternative of operating the particular line as an independent railroad.

12734 Rc4, a further development of asea's thyristor-controlled locomotives. Soderberg, E.A.B.; Gunnarsson, L. *ASEA (Allm. Sven. Elektr. A. B.) J.;* **50**: No. 2, 27-32(1977).

ASEA's thyristor-controlled locomotive class Rc4 is an example of a modular traction system, which permits the construction of different types of vehicle having a varying number of driven axles. The article describes the mechanical design, main circuits, control system, etc. of the Rc4 locomotive.

PIPELINE

REFER ALSO TO CITATION(S) 12622, 12623, 12624

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 12583, 12584

ENERGY SOURCES

12735 Coupling of thermal and electric power utilization in a brewery. Gneuss, G. *Energie;* **29**: No. 5, 143-145(May 1977). (In German).

Methods to increase productivity by means of better power utilization are considred. Design criteria for steam requirements as well as peak electric loads are demonstrated on a concrete example, a brewery. The advantages offered by coupling the thermal load with electric loads are explained.

12736 Use of reformed natural gas for heating glass furnaces. Kokarev, N.I.; Kozlov, A.S.; Pechenkin, S.I. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12737 Conversion of electrical energy into thermal energy for industrial processes. Multiple applications. Mann, E.W. *Maschinenmarkt;* **82**: No. 94, 1817-1820(Nov 1976). (In German).

Electric power can be utilized for thermal processes and heat treatment methods in industry. According to properties of the substances and to the effect desired, the following possibilities of electric heating are chosen: inductive, resistance- or dielectric heating. Various methods are discussed. The profitability of electric heating with regard to other methods has to be investigated in each case.

MATERIALS

REFER ALSO TO CITATION(S) 11801

12738 Energy accounting in connection with the production, processing, and utilization of magnesium. Buckeley, A. *Metall;* **31**: No. 8, 923-925(Aug 1977). (In German).

The lectures held during the Magnesium Congress are dealt with according to the following aspects: (1). use of magnesium in the automobile industry; (2). fabrication of magnesium hot-chamber die-cast parts; (3). energy consumption in connection with the fabrication of magnesium semifinished products; (4). reducing the energy used for processing magnesium; and (5) energy consumption in connection with magnesium primary production. 1 fig, 2 tables, 11 refs.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 11661, 11801, 12092

12739 Tips on turbocharger maintenance, the key to dependable operation. Bly, R.L. (Fiat-Allis Constr Mach, Inc). *Can. Min. J.;* **98**: No. 7, 41-43(Jul 1977).

The high speeds and the extreme temperatures under which turbochargers must operate, plus the extremely close balance of the units when manufactured, make it imperative that maintenance guidelines be followed faithfully, both for the turbocharger itself and the engine. To obtain satisfactory turbocharger life, engine starting and stopping procedures must be followed explicitly. Special attention also must be paid to several of the engine's systems, which are described.

12740 Energy management. Sugden, J.R. (Smethwick Drop Forg Ltd). *Metall. Met. Form.;* **4**: No. 7, 301-304, 306(Jul 1977).

The fuel economy problems in the drop forging industry are dealt with. The problems are defined, a management system for their analysis is discussed, and some of the practical actions that have been taken are examined. It is shown that throughput and the economies of forging have the greatest influence on fuel consumption.

12741 Energy recovery from liquefied natural gas. Pocrnja, A. (Linde, Munich, Ger). *Erdoel-Erdgas Z.;* **93**: No. 6, 208-210(Jun 1977). (In German).

To reduce the volume of natural gas for the purpose of transporting it, large quantities of gas are liquefied at the point of origin. Part of the energy necessary for this liquefaction is thus stored as cold energy in LNG. This cold energy in LNG, before regasification, represents a considerable, although untapped energy potential in the countries using large volumes of LNG. The author describes a process for energy recovery from liquefied natural gas with the help of a closed-cycle gas turbine.

12742 Characteristics of industrial gas burners. Rieder, G. (Montanuniv Leoben, Austria). *Gas, Wasser, Waerme;* **31**: No. 6, 186-189(Jun 1977). (In German).

Operation of burners with and without pre-mixing of gas and air is discussed. Various mixing devices are compared and evaluated. Relationships between furnace design and flame characteristics are investigated for fuel economy and simplified burner design.

12743 Economic effectiveness of control of main fan operation by a variation of the angle of inclination of blades. Majewski, W.; Kaczmarek, W. *Przegl. Gorn.;* **33**: No. 3, 113-118(Mar 1977). (In Polish with English abstract).

The problem of a true course of variation of the mine ventilation network parameters is analysed together with the problem of a better adaptation of main ventilation fans to the current requirements of that network. On the basis of a comprehensive statistical material, the amount of costs of energy used for the operation of main ventilation fans is determined and an attempt is made at the determination of economic effects attained by the control of fans. 4 refs.

12744 Optimizing the dimensions of crucible-type induction melting furnaces. Tevan, G.; Nagy, S. (Tech Inst fuer Schwerind, Miskolc, Hung). *Elektrowaerme Int., A, B;* **35**: No. B1, 42-48(Feb 1977). (In German).

The article deals with the dimensional optimization of crucible-type induction melting furnaces. The aim is to achieve the maximum efficiency which is the product of the electrical and of the thermal efficiency. It is shown which of the numerous factors involved affect the efficiency and how these correlate. The computational procedure is described and a number of results are mentioned as examples.

12745 Process and device of steam generation for industrial use. Pilz, F. German(FRG) Patent 2,531,418/A/. 20 Jan 1977. 9p. (In German).

Supplementary to the main patent P 2531419.6, it is proposed to use a disk-shaped box instead of a spherical one, having oval curved sides. The water-air mixture sprayed onto a heating pipe, which is wound in the shape of a spiral on one level. The evaporator surface is sprayed by several streams from various directions. Further claims are chiefly in accordance with the main patent.

12746 Process and device of steam generation for industrial purposes. Pilz, F. German(FRG) Patent 2,531,419/A/. 20 Jan 1977. 13p. (In German).

The following arrangement is suggested for steam generation plants which must be started up in a short time and which must be adapted often to changing demands. The water is atomized by means of compressed air and sprayed onto coiled tubes. These coiled tubes are streamed through with a heating agent and arranged in a spherical box. The turns of the coiled tubes have different diameters, so that there is an equal spacing between evaporator and shell surface. From this interface the produced steam-air mixture is led away. The evaporator is fitted advantageously with two input openings for the spraying streams of the water-air mixture. The direction of the spraying streams runs parallel with the level of the heating pipes. The generated quantity of steam can be regulated with the temperature of the heating agent and the quantity of sprayed water. Further claims concern the application and the arrangement of the pressure chambers and the inlet openings.

12747 Practical possibilities for energy saving in the firing of heavy-clay products. Schmidt, H.; Reinholz, C. *Keram. Z.;* **29**: No. 3, 121-122(1977). (In German).

Since we are still oriented towards the use of oil, and the known reserves of oil, as well as of gas and coal, will only last for another few decades, it is essential to economize on energy in the manufacture of heavy-clay products. Figures are quoted for high rates of consumption, and it is demonstrated that a reduction of fuel consumption is possible in principle. Various possibilities are also suggested for reducing the heat requirements in firing. In conclusion, there is a brief reminder of the heat linkage between kiln and dryer.

12748 Parallel and series supercharging. Andre-Talamon, T. *Entropie;* **13**: No. 74, 39-44(1977). (In French).

A technical, economic and industrial comparison is given between Hyperbar supercharging, where the engine and the turbosupercharger are arranged in parallel, and recent developments in conventional supercharging, where the engine and the turbosupercharger are arranged in series. The appliction of the Hyperbar system is compared with the most advanced results of conventional systems with two stages and intermediate cooling. With a similar level of complexity, the Hyperbar system enables the power to be doubled. The specific consumption of the engine with a very low compression rate is practically unchanged. The auxiliary combustion chamber which is extinguished when the engine supplies its power, makes it possible, by additional marginal consumption, to restore to the engine, particularly at a low speed, the torque curve of a natural intake engine. Finally, the industrial aspects, particularly those of the turbosupercharger, specific to the development of the highly supercharged Hyperbar engine are examined.

12749 Efficiency of electric motive power in industry. Murgatroyd, W.; Wilkins, B.C. (Imp Coll of Sci and Technol, London, Engl). *Energy (Oxford);* **1**: No. 4, 337-345(Dec 1976).

The paper indicates the methods used and the results obtained during a study of the energy losses incurred by industrial electric drives. Simple models are derived which permit the losses in a wide range of equipment to be assessed from measurements which do not involve interference with production. The study suggests that upwards of 50% of the electricity supplied to industrial rotating machinery is wastefully used in producing the final mechaical drive, and that this represents a significant fraction of national electricity production.

12750 Comparison of seawater desalination processes and their economics. Channabasappa, K.C. (Dept. of the Interior, Washington, DC). *Desalination;* **19**: No. 1/2/3, 535-554(Dec 1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

The four-fold increase in fuel prices and the ever escalating costs of the heat exchanger materials used in distillation plants have placed the reverse osmosis process in a decidedly cost advantageous position for use in sea water desalination. Results of research efforts currently underway, both in the U.S. and other countries, indicate that further advances will be surely forthcoming in the next 2 to 3 years. Because of the close similarity in the "unit operation principles" of distillation and reverse osmosis processes, there whould be no difficulty in retraining design engineers, sales personnel and plant operators in reverse osmosis technology. During the past 5 years, the percentage of the desalting market shared by reverse osmosis technology is steadily increasing. Over 80 percent of the brackish water desalination plants built (or under construction) over the last 3 years have been based on this process. Process reliability of seawater reverse osmosis technology has been established through operation of a number of small plants with desalting capacities up to 50,000 gpd. Plans are presently underway to construct new seawater reverse osmosis plants of 100,000 gpd capacity and above, and these are expected to be in operation during 1977. The experience gained in these plants should provide sufficient background and confidence for construction of multimillion gallons per day capacity seawater desalination reverse osmosis plants.

12751 Annular duct single-phase induction electromagnetic pump. Kano, Y. (Haruhata, Zoji). *Electr. Eng. Jpn. (Engl. Transl.);* **96**: No. 4, 83-88(Jul-Aug 1976).

It has been said that D.A. Watt was the first to study the single-phase induction motor (around 1953). NASA was also involved in the development of this type of electromagnetic pump aiming at its use for cooling the nuclear reactor. It is most important in the design of single-phase induction motor to determine (1) how to induce a large current in the fluid with low conductivity, (2) how to construct a simple air-tight duct with less viscosity, (3) the shape of the core to use in utilizing most effectively the magnetic flux, and (4) how to cool the coil efficiently when driving a high-temperature fluid. A new annular duct-type, single-phase induction electromagnetic pump is proposed. The structure and operating principle of this pump are described in detail. The state of the fluid in quasisteady-state condition is analyzed on the basis of Maxwell's equation. The driving force and pressure of the working fluid are derived from magnetic flux and current distributions. The calculated results agree very well with the measured ones.

12752 Process for the production of steam in an industrial plant with reduced energy consumption. Rojey, A.; Cohen, G. (to Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison). German(FRG) Patent 2,554,063/A/. 16 Jun 1976. 17p. (In German).

The invention concerns a method of saving energy in the production of steam in a refinery. The medium pressure steam required in the refinery is produced as usual by reducing the high pressure steam produced in the boiler by a reaction turbine to a medium pressure of 13 bar. But the low pressure is not produced, as usual, by further reduction of the medium pressure steam in a second reaction turbine where both turbines produce much more mechanical and electrical energy than is required in the refinery. Instead, the above mentioned high pressure turbine drives a compressor, which compresses pentane vapour in a pentane circuit to a pressure of 18 bar, this condenses in a heat exchanger, and thus produces the low pressure steam required in the refinery, then the pentane again evaporates in the refinery coolers and finally returns to the compressor.

12753 Yuma desalting plant design. Taylor, I.G.; Haugseth, L.A. (Bureau of Reclamation, Denver). *Desalination;* **19**: No. 1/2/3, 505-523(1976).

From 1. Desalination Congress of the American Continent proceedings; Mexico City, MX (24 Oct 1976).

The main features under Title I of the Colorado River Basin Salinity Control Poject are described. The key feature is the Yuma Desalting Plant. This membrane plant, with a capacity of over 100 Mgal/d (378,500 m^3/d), will be the largest plant of its type in the world. The desalting plant process selection, design and construction approach, and results of major studies undertaken in support of design and construction are presented. The Preliminary Engineering Analysis results and the Yuma Desalting Test Facility programs including pretreatment and desalting test results are presented. The water recovery, plant split, plant and river operations, and plant and equipment arrangement are described. Pretreatment descriptions include sludge handling facilities for the partial lime system. Capitol costs plus operation, maintenance, replacement, and power costs are presented. High recovery investigations and energy saving features are also discussed. Integrated operation and maintenance of the plant are discussed and the current status of the project is presented.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 12417

12754 (COO/2862—2/2) Industrial applications study. Volume II. Industrial data base. Final report. (Drexel Univ., Philadelphia, Pa. (USA); United Technologies Research Center, East Hartford, Conn. (USA); Mathematica, Princeton, N.J. (USA)). Dec 1976. Contract EY-76-S-02-2862. 128p. Dep. NTIS, PC A07/MF A01.

An initial evaluation of the waste heat recovery and utilization potential in the manufacturing portion of the industrial sector is presented. The scope of this initial phase addressed the feasibility of obtaining in-depth energy information in the industrial sector. Within this phase, the methodology and approaches for data gathering and assessment were established. Using these approaches, energy use and waste heat profiles were developed at the 2-digit level; with this data, waste heat utilization technologies were evaluated.

12755 (COO/2862—4/4) Industrial applications study. Volume IV. Industrial plant surveys. Final report. (Drexel Univ., Philadelphia, Pa. (USA); United Technologies Research Center, East Hartford, Conn. (USA); Mathematica, Princeton, N.J. (USA)). Jan 1977. Contract EY-76-S-02-2862. 108p. Dep. NTIS, PC A06/MF A01.

An initial evaluation of the waste heat recovery and utilization potential in the manufacturing portion of the industrial sector is presented. The scope of this initial phase addressed the feasibility of obtaining in-depth energy information in the industrial sector. Within this phase, the methodology and approaches for data gathering and assessment were established. Using these approaches, energy use and waste heat profiles were developed at the 2-digit level; with this data, waste heat utilization technologies were evaluated. This study represents an important first step in the evaluation of waste heat recovery potential.

12756 Waste heat steam generator. Kuemmel, J. (to Oschatz G.m.b.H., Essen (Germany, F.R.)). German(FRG) Patent 1,817,002/C/. 16 Dec 1976. 4p. (In German).

The design is described of a waste heat steam generator, used particularly for the cooling of gases. The generator has an upright cylindrical boiler sheath with removable cover and boiler tubes arranged parallel to the boiler axis. The boiler is installed in such a way that easy maintenance and repair is possible. The boiler tubes form their own system of rising and falling tubes with collectors, and the remaining boiler tubes are supported only by the cover.

12757 Engine test cells offer scope for energy recovery. Brown, C.R.W. *Energy Int.;* **14**: No. 11, 43-44(Nov 1977).

Engine test shops, besides checking engine performances, are also producing power that could be recovered and used as process heat or fed to the public power system. To be feasible, the energy recovered must be available when needed and in a usable form. Calculations made on the energy balance of diesel engines during proof testing revealed the most significant energy waste is at the dynamometer. The characteristics and needs of each plant must dictate whether the energy is used as hot water or is converted to electricity, the choice determining which type of dynamometer is used. Potential savings and capital investment costs are estimated and found to justify placing major priority on energy recovery systems in test facilities. (DCK)

12758 Chemical reaction cycles for the recovery of low-level thermal energy. Fujii, S.; Kameyama, H.; Yoshida, K.; Kunii, D. (Tokyo Univ.). *J. Chem. Eng. Jpn.;* **10**: No. 3, 224-228(Jun 1977).

At present, much thermal energy exhausted from industrial proceses has been unrecoverably lost. A new method, a chemical heat pump, is proposed for recovering such low-level energy by use of chemical reaction cycles. Through this method, the low-level energy can be converted to higher and more useful energy. A thermodynamic study of this method and the practical example, Triangle Process 1, 2, and 3 are described.

12759 Gas-powered heat pumps - initial test results. Pohle, J.; Rostek, H.; Wilmers, G. *Gas Waerme Int.;* **26**: No. 4, 163-167(Apr 1977). (In German).

The term 'gas heat pump' is used to describe a heating aggregate in which a stationary combustion engine - with gas as fuel - drives a compression heat pump. The waste heat of the engine is utilized by transforming it into effective heat which additionally improves the efficiency of the heat-pumping process. On today's technical level, gas heat pumps can be constructed using conventional components. Large plants can be composed - for example for regional heating purposes - using water, as far as possible, as 'environmental heat source'. An example for this will be shown in the last chapter. New developments are necessary if small gas heat pumps in their use equivalent to the conventional heating systems and exceeding them in profitability are to be used in building heating. The following parts report on a development plan supported by the Federal Ministry of Research and Technology. Within the frame of this plan, an experimental plant was constructed at the Ruhrgas AG, the first measurement results of which are already available. This plant is introduced, and the results are made public.

12760 Heat pump heating with heat pumps driven by combustion engines or turbines. Hein, K. (to Stadtwerke Heidenheim A.G. (Germany, F.R.)). German(FRG) Patent 2,530,503/A/. 27 Jan 1977. 5p. (In German).

The heat pump described is driven by a gas Otto cycle engine, or a gas- or light- or heavy-oil fired Diesel engine. The claim refers to the use of waste heat of the engines by feeding into the input circuit of the heat pump. In addition, a drive by an electrical motor-generator or power production can be selected at times of peak load in the electrical supply network.

12761 Contribution to heat recovery in glass melting furnaces. Becker, K. *Glastech. Ber.;* **50**: No. 3, 47(1977). (In German).

12762 Recuperation in glass melting furnaces. Lange, K. *Glastech. Ber.;* **50**: No. 3, 47(1977). (In German).

12763 Waste heat power plants in pollution abatement and utility systems. Strach, L. German(FRG) Patent 2,500,052/A/. 8 Jul 1976. 1p. (In German).

The application is concerned with a waste heat power plant. Flue gas of a refuse incinerator is to preheat the turbine air of a power station in a recuperator after leaving the compressor and before entering the combustion chamber. The current generated by the power station is to charge the batteries of electric-powered busses, or to be fed into the network of rail vehicles, or to produce H_2 electrolytically. The waste heat of the gas turbine is to be used for heating.

12764 Improvement of plants for the production of cement using a drying method by recovery of the energy lost by the waste gases. Retali, R.; Pacault, P.H. (to Fives-Cail-Babcock, 75 - Paris (France)). German(FRG) Patent 2,558,722/A/. 8 Jul 1976. 11p. (In German).

In the dry process the hot waste gases of the rotary kiln and the clinker-cooling are used mainly for the drying and preheating of the ground raw material. In order to further improve the heat economy, the inventor recommends that the waste gases from the rotary kiln from the first preheating step be fed into a steam vessel. In this way a superheated steam is produced at a pressure of 30 to 60 bar and a temperature of 300-400°C. The steam is used to generate electric power. 40 kWh per ton of clinkers can be generated without additional fuel consumption. Further claims imply the arrangement of the boiler and the control devices.

12765 Heat exchanger combination for small heat power plants, which works primarily on the basis of motors or turbines operated by gas or light oil. Hein, K. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,458,252/A/. 16 Jun 1976. 5p. (In German).

A heat-exchanger-combination is described. In a joint housing several separated chambers and a mix-space are positioned; from the chambers heat can transfer to the pipe bundles, which lie inside them; in the mix-space heat is transferred from a gas medium to a fluid medium sprayed out of a chamber. The gases flowing in the mix-space are preferably exhausts from internal combustion engines or turbines, which supply the mechanical energy for the small heat power plant. The chambers with the heat exchanger mediums are constructed as storage or rather have selectable, lockable connections with heat storage tanks. Auxiliary electrical heating elements are positioned in the chambers, which produce a variable usable heat current independently or in conjunction with the heat current of the heat transfer medium. The condition of the combination is held at the necessary operating level by connection with a control and observation device.

12766 Method and device for alternately heating and cooling a heat exchanger of a heating-cooling plant. Schaefer, O. German(FRG) Patent 2,453,622/A/. 20 May 1976. 29p. (In German).

The patent claim is concerned with conserving heat energy when operating a press which has to be heated within a few minutes from 40 to 180°C and cooled down again at regular intervals. According to the application, at least two sections of the press will be operated separately. Their heating and cooling phases alternate from each other which means that the heating liquid from the first press section is used during the heating phase for preheating and during the cooling phase for precooling in the second section. In addition to heating boiler and coolant container, there is to be a number of liquid storage tanks for intermediate temperatures. Via a control unit they can be linked up with the press by means of valves.

12767 Use of waste heat from large refrigerating units with saving of heat energy. Heidenwolf, H. German(FRG) Patent 2,405,031/A/. 7 Aug 1975. 6p. (In German).

The invention concerns a process where the circulating air of large refrigerating units, e.g. large refrigeration units in supermarkets, is not blown out into the open in the winter and transitional periods of the year, but is used for the heating of sales areas, in order to save heat energy. For this, two wall penetrations between the refrigeration unit chamber and the rooms to be heated, one circulation air fan and two ventilation flaps are required, which either produce the connections between the refrigeration unit chamber and the rooms to be heated or in summer produce connections between the chamber and the ambient air.

12768 Technical heat evaluation of the recuperation of the physical exhaust from industrial furnaces. Pt. 2. Summary. Cernoch, S. *Fachber. Oberflaechentech.;* **13**: No. 9, 609-612, 614-615(1975). (In German).

3 figs.

A survey is given of calculation methods and new results for maximum exhaust heat recovery through recuperators in countercurrent in industrial furnaces. The theory of heat utilization in countercurrent and direct current recuperation is discussed and, well-known formulas of fuel saving from Heiligenstaedt, Schack, Russian and American practice are compared. In comparison to the initial state, thermokinetic and thermodynamic relationships are of importance for the optimization of the furnace parameters.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 12122

12769 Slag and quarry waste as pipe bedding material. Banerjee, A.C. (Bokaro Steel Ltd., India). *J. Inst. Eng. (India), Environ. Eng. Div.;* **57**: 89-90(Jun 1977).

External loads ordinarily control the design of sewer pipes. By using crushed stone (or blast furnace slag) and quarry dust as bedding material, a saving of about Rs 59 per meter length can be attained and the waste materials are conveniently utilized.

12770 Combustion of heterogeneous industrial wastes. Sinning, B. *Maschinenmarkt;* **83**: No. 26, 473-475(Apr 1977). (In German).

In contrast to household waste, waste from industrial production processes and industrial waste in general cannot be disposed of without pre-treatment. Basically, there are two methods of pre-treatment. Waste combustion at certain minimum temperatures guarantees complete oxidation. Chemical-physical treatment of the wastes in several stages produces harmless compounds ready for disposal. Rational use of the heat energy produced by waste combustion serves to reduce the costs of the plant. On the other hand, it also requires detailed studies on the site of the plant and on potential users of heat energy. The combustion method and the furnace to be chosen depend mainly on the waste composition.

12771 Mechanisms and damage phenomena of high-temperature corrosion on the superheater tubes of large mineral coalfired boilers. Effertz, P.H.; Wiume, D. *Maschinenschaden;* **50**: No. 3, 93-108(1977). (In German).

From International conference on fireside corrosions and contaminations in thermal power stations. 91. event of the European Federation of Corrosion; Essen, Germany, F.R. (1 - 2 Jun 1977).

28 figs.; 1 tab.; 18 refs.

High-temperature corrosion is particularly common on the flue-gas exposed, coated outer surfaces of the final and intermediate superheater tubes in smelting furnaces. The coal ash components transported in the flow of flue gas in a gaseous, liquid, and solid state are condensed, deposited, and partly fused on the cooler tube surfaces on which they impinge. According to Jackson, partial condensation, sublimation, and diffusion in the radial temperature field of the coatings thus established cause a concentration particularly of alkaline sulphates in the areas near the tubes. In combination with the oxygen and sulphoric oxides contained in the flue gas, these salines then result in direct or indirect tube material oxidation. The present paper sets out to compare the existing theories with findings obtained from numerous loss investigations.

12772 Method for reclaiming waste lubricating oils. Whisman, M.L.; Goetzinger, J.W.; Cotton, F.O. (to Energy Research and Development Administration). US Patent Application 734,838. 22 Oct 1976. 12p.

A method is described for purifying and reclaiming used lubricating oils containing additives such as detergents, antioxidants, corrosion inhibitors, extreme pressure agents and the like and other solid and liquid contaminants. Preferably, the used oil is first vacuum distilled to remove water and low-boiling contaminants, and the dried oil is then treated with a solvent mixture of butanol, isopropanol and methylethyl ketone which causes the separation of a layer of sludge containing contaminants, unspent additives and oxidation products. After solvent recovery, the desludged oil is then subjected to conventional lubricating oil refining steps such as distillation followed by decolorization and deodorization.

12773 Method for the separation of fly ash from flue gas in a closed system with wet scrubber. Melin, D.D. Jr.; Grieve, D.F. (to Krebs Engineers, Menlo Park, Calif. (USA)). German(FRG) Patent 2,613,639/A/. 7 Oct 1976. 29p. (In German).

The invention is based on the task to develop a method for the separation of fly ash from industrial flue gases (combustion of fossil fuels) in a wet scrubber system, of which the water household is to be adjusted in such a way that the outflow from wet scrubbers with its suspended and dissolved solids meets the orders on environmental protection. Accordingly, the invention is based on a closed system with at least one wet scrubber, where in the flue gas contacts a washing liquid containing an inert dilution medium, namely sodium sulfate and magnesium sulfate, having a pH value of 6.0. Furthermore, Na is added in the form of ions, reacting with SO_2 present in flue gas to sodium sulphite and/or sulfate. It is thus the task of the Na_2SO_4 and $MgSO_4$ added to the washing solution to reduce the delution speed of fly ash components. The solids carried along by the washing liquid outflow are separated. After taking away part of the washing solution and passing an evaporator in order to recover sodium and magnesium salts, the separated washing solution is recirculated to the washing area.

MUNICIPALITIES AND COMMUNITY SYSTEMS

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 12573

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 12576

12774 (INIS-mf—3664, pp 43-69) **CGR MeV program for water and liquid sludges treatment with high-energy electron beams. Pt. 1. Preliminary investigations.** Gallien, C.L. (Paris-5 Univ., 75 (France)); Icre, P. (Societe de Recherches Techniques et Industrielles (SRTI), 78 - Buc (France)); Levaillant, C. (CGR MeV, Orsay, France); Montiel, A. (Service de Controle des Eaux de la Prefecture de Paris, France). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

Research on the application of high-energy electron beams treatment to water and liquid sludges is described. Topics discussed include limitations of conventional methods of water treatment, dosimetry, biological assays with Pleurodeles waltlii, radioactivity measurement, and chemical and bacteriological analysis.

12775 (INIS-mf—3664, pp 99-107) **Effects of gamma irradiation on physical-chemical properties and dewatering characteristics of sludges.** Groneman, A.F. (Association Euratom-ITAL, Wageningen (Netherlands)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

Separation of solids from liquids is a paramount operation in the processes applied in treating sewage and waste waters. Therfore, studies were undertaken to investigate effects of gamma irradiation on the physical-chemical properties of sludges and the de-watering characteristics of anaerobically digested sludge and aerobically activated sludge. A dose of 300 krad reduced the specific resistance of anaerobically digested sludges from 33 x 10 sec ^{2}/g to approximately 10 x 10^9 sec^2/g. This conditioning effect was little influenced by the presence of oxygen or nitrogen. Pasteurization increased the specific resistance to filtration up to 48 x 10^9 sec^2/g. Dewatering characteristics of raw sludge were not affected by irradiation in the presence of oxygen but a slight conditioning effect was noticed when the sludge was irradiated under deaerated conditions. Experimental evidence indicated that gamma irradiation detached organic substances from the sludge flocks resulting in a decrease of the specific resistance and an increase in the Total Organic Carbon (TOC) and the Chemical Oxygen Demand (COD) in the filtrates. Elutriation reduced but did not eliminate the conditioning effect of gamma irradiation.

12776 (INIS-mf—3664, pp 108-120) **Influence of gamma-irradiation on the behaviour of sewage sludges.** Hegeman, W.; Guenthert, W. (Technische Univ. Muenchen (Germany, F.R.)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

Since summer, 1975 the Institute of Water Quality Management and Sanitary Engineering of The Tehnical University Munich has been performing tests on the alterations of the quality and the behavior of sewage sludge caused by gamma-irradiation at the Geiselbullach treatment facilities. The tests comprise studies of the thickening ability in laboratory scale thickeners (V = 30 l) and the determination of the specific resistance to filtration of untreated, pasteurised and irradiated sludges. The concentration of the supernatent liquor is characterized by the measurement of BOD_5 and COD. Test results of the dewaterability of the different sludges in filter presses and the amount of coagulants necessary for sludge conditioning are presented.

12777 (INIS-mf—3664, pp 183-190) **Concept for continuous sludge irradiation with radioisotopes.** Herkert, B. (Leybold-Heraeus G.m.b.H. und Co. K.G., Hanau (Germany, F.R.)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

A design for the continuous sludge irradiation with the aid of ^{60}Co-sources is presented. The sludge is moved slowly through a vertically arranged tube from bottom to top. At the lower part of the tube rotates the source rack with suitably situated rod sources. The driving mechanism for the sources leads through the tube to the top of the irradiator. The advantage of the proposed design subsists in the careful treatment of the sludge during irradiation.

12778 (INIS-mf—3664, pp 200-206) **Technical and economical aspects of a large and a small plant for irradiation of liquid waste.** Herrnhut, H.; Marsch, U.; Bosshard, E. (Sulzer Bros. Ltd., Winterthur (Switzerland)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

A description is given of the further development of the irradiation plant for sewage sludge which is in operation at the sewage water treatment plant of the Abwasserverband Ampergruppe at Geiselbullach. Taking into consideration the operating experience, the conception of the plant was optimized; the design is simplified. The loading and reloading of the radioactive sources could now be carried out during operation of the plant. The economical aspects were considered too and the calculated cost of the treatment was summarized in a table.

12779 (INIS-mf—3664, pp 39-42) **Data on the irradiation of liquid manure artificially infected with foot-and mouth disease virus.** Simon, J.; Solyom, F.; Felkai, V.; Oroszlany, P. (PHYLAXIA Veterinary Biologicals and Feedstuffs Co., Budapest, Hungary). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

Research on the application of an ionizing radiation treatment to liquid manure infected with foot and mouth disease virus is described. Virus suspensions diluted with a phosphate buffer solution showed a considerable decrease of virulence already at an exposure to 0.4 - 0.8 Mrad at low initial titre. 1.2 Mrad proved to be effective also against high concentrations of the virus. However, with liquid manure used as diluent, a certain protective effect was noted against the destructive influence of radiation on the virus.

12780 (INIS-mf—3664, pp 70-86) **Thermoradiation treatment of sewage sludge using reactor waste to obtain acceptable fertilizer or animal supplement feed.** Sivinski, H.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

This document is a report of the Beneficial Uses Program. This program consists of a number of activities at Sandia Laboratories to develop the necessary technology for cost-beneficial use of a maximum amount of radioactive waste. Major activity is currently concentrated in the Waste Resources Utilization Program which has as its objective the use of cesium-134/137 as a gamma radiation source, coupled with modest heating, to treat sewage sludge to rid it of pathogenic organisms so that it may safely be used as a fertilizer or a feed supplement for ruminant animals.

12781 (INIS-mf—3664, pp 194-199) **Sewage sludge irradiation with electrons.** Tauber, M. (Allgemeine Elektricitaets-Gesellschaft AEG Telefunken, Hamburg (Germany, F.R.)). 1976.

From International conference on waste irradiation; Munich, F.R. Germany (8 Jun 1976).

In Radiation for pollution abatement.

The disinfection of sewage sludge by irradiation has been discussed very intensively in the last few months. Powerful electron accelerators are now available. The main features of the irradiation of sewage sludge with fast electrons are discussed and the design parameters of such installations described. AEG-Telefunken is building an irradiation plant with a 1.5 MeV, 25 mA electron accelerator, to study the main features of electron irradiation of sewage sludge.

12782 **Pyrogas process.** Schueler, H.U. *Wasser, Luft Betr.;* **21**: No. 6, 362-363(Jun 1977). (In German).

Pyrolysis is attracting more and more attention as an alternative to incineration, because it allows dedusting problems to be mastered much more easily. In the Federal Republic's ecological report, the further development of this process has been expressly stressed in the entire complex of thermal waste disposal techniques.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

12783 Combustion engine without lubrication and without sealing difficulties. Wenk, P. German(FRG) Patent 2,542,711/A/. 7 Apr 1977. 1p. (In German).

An IC-engine is presented, the closed cylinder of which is cylinder and piston all in one and a tombac bellows is the power generator. The engine does not need internal lubrication. The mobile parts need not be sealed. The principle of the engine is applicable for compressed air, liquids, gases and vapors. Cylinder cooling is to be without problems.

12784 Basic principles of heat pump techniques. Paul, J. (Essen Univ. (Gesamthochschule) (Germany, F.R.). Lehrstuhl und Inst. fuer Angewandte Thermodynamik und Klimatechnik). *Oel- Gasfeuerung;* **22**: No. 2, 60-64(Feb 1977). (In German).

The main elementary principles of the heat pump are presented in an abbreviated form.

12785 Method and equipment for thermal insulation of a building. Gawler, B.C.F. (to Imperial Chemical Industries Ltd., London (UK)). German(FRG) Patent 2,607,323/A/. 2 Sep 1976. 33p. (In German).

A method for filling hollow spaces in buildings with insulating material is described. Two coreactants, fed through separate channels, turn into plastic foam in the hollow space. The inlets are equipped with flow meters controlling the throughput, the result of which is high-quality insulating foam.

SPARK-IGNITION

REFER ALSO TO CITATION(S) 12807, 12813

12786 Comparison between diesel and gasoline passenger cars. Pike, D.A.; Wright, M.J. *Entropie;* **13**: No. 74, 45-56(1977).

In order to provide reliable information on the merit of Diesel compared to gasoline passenger cars in respect to performance, fuel consumption, exhaust emissions and noise, tests were carried out on a range of Diesel and gasoline powered vehicles. These tests were performed not only at constant speeds but also in simulated city driving conditions. The results of these tests have shown that, where direct comparisons are applicable, a Diesel engined vehicle has an advantage over the gasoline one in respect of fuel consumption and exhaust emissions but is inferior in respect of performance and noise.

DIESEL

REFER ALSO TO CITATION(S) 12786, 12822

12787 Prediction of instantaneous pressure during combustion process of a four stroke diesel engine. Saxena, L.M.; Dave, R.K.; Jain, N.L. (Gov Eng Coll, Jabalpur, India). *J. Inst. Eng. (India), Mech. Eng. Div.;* **57**: 334-338(May 1977).

The pressures developed in a four stroke diesel engine have been predicted with the help of the Yu.V. Zakherebetkov method. These predicted values compare well with the experimental values. The variation of pressure pattern with the change in the heat transfer coefficient obtained by changing the constant in N.R. Brilling's expression has also been predicted. A short discussion of the paper is appended. 9 refs.

12788 Contribution of the diesel engine to very high-efficiency units. Daugas, C. *Entropie;* **13**: No. 74, 31-38(1977). (In French).

The Diesel type of compression ignition engine is overall the most efficient transformer of chemical into mechanical energy, 20 MW units now exist whose efficiency reaches 45%. 55% of the energy introduced is nevertheless wasted in the form of heat. In these days of energy-saving, it is essential to recover this and use it for heating or to produce additional power. Results and research trends are described.

TURBINE

REFER ALSO TO CITATION(S) 12821

12789 (COO—2749-18) **Baseline gas turbine development program. Eighteenth quarterly progress report.** Schmidt, F.W.; Wagner, C.E. (comps.). (Chrysler Corp., Detroit, Mich. (USA)). 30 Apr 1977. Contract EY-76-C-02-2749. 261p. Dep. NTIS, PC A12/MF A01.

Progress is reported for a program whose goals are to demonstrate an experimental upgraded gas turbine powered automobile which meets the 1978 Federal Emissions Standards, has significantly improved fuel economy, and is competitive in performance, reliability, and potential manufacturing cost with the conventional piston engine powered, compact-size American automobile. Initial running of the upgraded engine took place on July 13, 1976. The engine proved to be mechanically sound, but was also 43% deficient in power. A continuing corrective development effort has to date reduced the power deficiency to 32%. Compressor efficiency was increased 2 points by changing to a 28-channel diffuser and tandem deswirl vanes; improved processing of seals has reduced regenerator leakage from about 5 to 2.5% of engine flow; a new compressor turbine nozzle has increased compressor turbine stage efficiency by about 1 point; and adjustments to burner mixing ports has reduced pressure drop from 2.8 to 2.1% of engine pressure. Key compressor turbine component improvements are scheduled for test during the next quarterly period. During the quarter, progress was also made on development of the Upgraded Vehicle control system; and instrumentation of the fourth program engine was completed by NASA. The engine will be used for development efforts at NASA LeRC.

12790 Ignition system for a gas turbine. Richey, J. M.; Stockton, W.W. (to General Electric Co., Schenectady, N.Y. (USA)). German(FRG) Patent 2,558,756/A/. 8 Jul 1976. 21p. (In German).

The invention relates to an electric ignition system for gas turbine engines. The system consists of two completely independent ignition circuits each of which includes a power source, an ignition coil, and a spark plug. A generator driven by the engine automatically supplies electricity to its ignition system when the engine is started and the flame for the engine is quenched. This quenching is indicated by the slowdown of the engine. Otherwise this ignition circuit is switched off to prolong the life of the spark plug. The other ignition circuit is supplied electricity from the battery on board of the aircraft and is switched on and off by the crew as the need arises. It can be operated either individually or together with the automatic ignition circuit.

12791 Gas turbine drive with heat transfer bearings for shaft. Petrie, J.A.; Gardiner, T.E.G.; Clampitt, J.A. (to Ministry of Defence, London (UK)). German(FRG) Patent 2,140,337/C/. 20 Nov 1975. 10p. (In German).

A gas turbine drive with heat transfer bearings for the shaft is described. The shaft is held in loose bearings at its ends, which permit axial thermal expansion. It is connected with a turbine rotor, which is separated by an axial sealing gap from a sealing part held firmly in a radial driving unit plane. An additional axial cylindrical part is fixed with one end on the shaft between the loose bearings, at the other end it is held firmly in an axial direction by a fixed bearing. The material of the additional parts (nickel-cobalt-steel) has a smaller temperature coefficient of expansion than the shaft material. In this way the axial displacement of the rotor due to thermal expansion can be suited to the axial thermal expansion of the driving unit housing.

12792 Gas turbine drive, preferably jet engine for aircraft, with cooling air and possibly baffle air extraction. Kohler, G. (to Motoren- und Turbinen-Union G.m.b.H., Muenchen (Germany, F.R.)). German(FRG) Patent 2,042,478/C/. 14 Aug 1975. 6p. (In German).

A gas turbine drive, preferably a jet engine for aircraft, having several shafts is described. The mechanically independent high pressure compressor is arranged behind the low pressure compressor with regard to flow. In the end stages of the compressor, there are extraction openings for turbine cooling air and possibly baffle air. With gas turbine drives one must ensure that during starting up, the flow in the compressor before the combustion chamber does not break off, i.e. pumping of the high pressure compressor during acceleration must be prevented. This is done in the arrangement of the invention in a simple constructive way. The appreciable advantage of the invention compared with known methods consists of the fact that appreciable arrangements for the cooling and possibly baffle air extraction and for the flow of extracted air can, if necessary, also be used for high pressure air extraction or blowing.

12793 Fuel controller for gas turbine drives. Bloom, J.L. (to Lucas Industries Ltd., Birmingham (UK)). German(FRG) Patent 1,812,779/C/. 7 Aug 1975. 5p. (In German).

A fuel controller for gas turbine drives, with a control slider which is axially adjustable by a pressure capsule is described. While the previously known types with coaxial arrangement of pressure capsule and control slider could not be used because of the excessive length for lifting engines with vertical starters, and another type with parallel arrangement of pressure capsule and control slider is too high, the arrangement according to the invention, because of its small dimensions, can be used in the smallest space.

12794 Arrangement for the control of the fuel supply to a gas turbine plant. Bloom, J.L. (to Lucas Industries Ltd., Birmingham (UK)). German(FRG) Patent 1,808,735/C/. 6 Mar 1975. 4p. (In German).

An arrangement for the control of the fuel supply to a gas turbine plant with two fuel valves adjustable by axial control sliders

is described. While a previously known arrangement with coaxial arrangement of the control sliders is too long to be able to use it in vertical starters, the arrangement according to the invention, because of its compact construction, only requires a minimum amount of space.

12795 Axial gas turbine. Widder, H.; Vollmer, K.; Hirsch, P. (to Licentia Patent-Verwaltungs-G.m.b.H., Frankfurt am Main (Germany, F.R.); AEG-Kanis Turbinenfabrik G.m.b.H., Nuernberg (Germany, F.R.)). German(FRG) Patent 2,352,285/C/. 6 Mar 1975. 4p. (In German).

An axial gas turbine, which can achieve very short starting times and a stable working point at the rated speed without requiring a speed controller, is described.

ROTARY

12796 Outside-axle, rotating-piston, meshing internal combustion engine. Nilsson, H.R.; Pamlin, R. (to Svenska Rotor Maskiner AB, Stockholm). German(FRG) Patent 2,503,706/C/. 7 Apr 1977. 3p. (In German).

The task of the device is to find a special arrangement in an internal combustion engine of the sort described in the beginning. The arrangement is to allow to use an ordinary cheap fuel atomizing system. According to the device, this problem is solved by arranging in the casing an over-flow duct with a fuel atomizing device between the operation chamber formed before the operation phase of the two rotors, with partially compressed air, and the operation chamber formed by the finned rotor or grooved rotor and the jacketing, with air which is not compressed yet.

EXTERNAL COMBUSTION ENGINES

12797 Device for the conversion of heat into mechanical energy. Meijer, R.J.; van Witteveen, R.A.J.O. (to Philips Gloeilampenfabrieken N.V., Eindhoven (Netherlands)). German(FRG) Patent 1,601,463/C/. 4 Nov 1976. 9p. (In German).

The invention concerns a device which makes it possible to drive a thermal engine (preferably a hot-gas motor) without the necessity to introduce oxidation agents from the atmosphere and to exhaust waste gas. This arrangement is a variant of the same inventor (refer to Patent 1601462). The additional patent presents the following basic elements for the device: A liquid metal circulates within a space having the shape of a longitudinal culvert. This partly dispenses the heat to a working agent. The heat production is regulated by a dosed addition of a reaction medium from a second tank. The volume variations of the metal and the circulating channel are compensated by inert gas coming from a third tank. A further circulating channel, containing a mixture of metal like NaK, is provided for the operation of hot-gas engines. This heat carrier heats the motor and exchanges the heat with the primary heating circuit of the first tank.

ELECTRIC-POWERED SYSTEMS

12798 (SAN/1215—1) Electric and hybrid vehicle performance and design goal determination study. Final report. Brennand, J.; Curtis, R.; Fox, H.; Hamilton, W. (General Research Corp., Santa Barbara, Calif. (USA)). Aug 1977. Contract EY-76-C-03-1215. 192p. Dep. NTIS, PC A09/MF A01.

Recommendations are set forth for performance standards for near-term and advanced electric and hybrid vehicles. Limited market surveys and interviews with present owners of electric vehicles indicated that the most important criterion for private vehicles is low operating cost. This criterion, combined with the low specific energy density and relatively short life of present storage batteries, was the key factor in the minimum performance specified for near-term private electric vehicles: two or more passengers, 50 km range over the SAE J227a/C driving schedule, with a maximum energy use of about 0.9 MJ/km (0.4 kWh/mi). Near-term commercial vehicles have even lower recommended minimum performance, including 50 km on the (less demanding) SAE J227a/B schedule. Heat-engine battery-electric hybrid vehicles may provide the driving range lacking in electric vehicles and use appreciably less fuel than conventional vehicles. Performance standards recommended for near-term hybrid vehicles call for essentially the same performance as for comparably sized near-term electric vehicles, except for increased range capability. Development specifications recommended for advanced hybrids call for substantially reduced petroleum fuel consumption and the same acceleration capability exhibited by present conventional subcompact cars. Performance standards for a light agricultural utility vehicle are developed.

12799 (SAN/1335—1) Recommended performance standards for electric and hybrid vehicles. Underhill, B.; Gott, P.; Hurter, D. (Little (Arthur D.), Inc., Cambridge, Mass. (USA)). Sep 1977. Contract EY-76-C-03-1335. 156p. Dep. NTIS, PC A07/MF A01.

Minimum performance standards for electric and hybrid vehicles were developed. The standards cover passenger cars and commercial vehicles, with the latter having possible agricultural uses. The primary results cover performance parameters such as payload, acceleration time, top speed, range (both constant speed and on an SAE J227a schedule C cycle), maximum energy consumption, gradability, battery life, battery recharge time, safety standards, handling, weatherproofing, audio and radiation noise, and maintainability. The performance standards are substantially less than those of conventional automobiles but represent a compromise between perceived user needs, actual user needs, measured and claimed performance of existing vehicles, the views of highway planners, views as expressed by manufacturers, design studies conducted by contractors for ERDA, availability in the near term, and cost. The performance standards for hybrid vehicles reflect the same standards for an all electric vehicle except that the engine is used to extend the vehicle range so as to increase its utility.

12800 (UCRL—52000-77-6, pp 10-16) Car for tomorrow: a quasi-electric-drive vehicle. O'Connell, L.G. Jun 1977.

In Energy and technology review.

Highway vehicles account for 75 percent of the national energy need in transportation, consuming over one-sixth of the yearly energy demand. Almost all of our highway vehicles are powered by internal combustion engines that use petroleum, a commodity expected soon to be in short supply. Because of this, alternative vehicle propulsion methods are actively under development. A survey of some alternative concepts is presented. One promising choice is the electric vehicle. Powered by batteries or a battery-flywheel combination, electric vehicles draw their energy from the nation's electric power network. Since the network's power can be generated by plants other than petroleum-burning plants, widespread use of electric vehicles could reduce transportation's use of petroleum. Electric vehicles cannot now match the range of conventional cars, although they can compete in performance and fuel cost. This range limitation should cease to exist by the early 1990's. Until then, one way to reduce petroleum use is to build electric vehicles with a small internal-combustion-engine adjunct—a transition vehicle. This car would be powered by battery most of the time and by the combustion engine when an extended range is required.

12801 Comparison of electric drives for road vehicles. Bader, C.; Stephan, W. (Deutsche Automobilgesellschaft m.b.H., Esslingen (Germany, F.R.)). *Elektrotech. Z., A;* **98**: No. 1, 22-26(Jan 1977). (In German).

From 4. international electric vehicle symposium; Duesseldorf, Germany, F.R. (31 Aug 1976).

The low energy-storage capacity of the electrolytic energy-storage apparatus available at the moment limits the practical use of electric vehicles to meeting the requirements for restricted areas. But in this field of application, conversion from drive with internal combustion engine to electric drive can be considered only if a reduction of costs is achieved with electric drive. From the wide range of possible drive units the most suitable is found to be the dc squirrelcage motor the speed of which is controlled by field weakening. In the case of a motor with conventional design, the controllable drive range is limited to about 1 : 3, so that generally additional measures are required for extending the drive range. But if the motor is fitted with a compensation winding, field weakening to give a controlled speed range of 1 : 8 can be obtained. To evaluate the different drive units under consideration use is made of the acceleration when, according to the drive system, advantages are obtained from the point of view of energy consumption with disadvantages in acceleration time, and vice versa. By using vehicles proven in practice with different drive systems, either with hydrodynamic transducer and battery switchover, or else with changeover gear and mechanical clutch, the overall construction of the different control and protective arrangements are demonstrated. It is then found that the extra cost of regulation in the case of automatic drive operation is partly compensated by the additional protective devices which are required to limit the effects of any incorrect operations with a manually-operated drive.

12802 Circuit for regenerative braking of dc-electric-powered vehicles. Dreiser, L. (to Kiepe Elektrik G.m.b.H., Duesseldorf (Germany, F.R.)). German(FRG) Patent 2,200,328/C/. 18 Nov 1976. 2p. (In German).

A circuit arrangement is described for generator braking of electric dc-driven-vehicles with serial engines arranged in crossed brake circuit. The circuit helps to avoid disadvantages which had occurred until now during braking in crossed brake circuits and were due to the differring lengths of the lines leading to the exciter-field windings.

12803 Current collector for electrically driven vehicles without rails. Dietrich, E.; Fischer, K.P.; Fritzsche, A.; Seidl, E.; Wuch, P.

(to Dornier-System G.m.b.H., Friedrichshafen (Germany, F.R.)). German(FRG) Patent 2,460,843/A/. 1 Jul 1976. 17p. (In German).

The invention concerns the current collector on the roof of an electrically driven vehicle without rails, e.e. a so-called trolley bus. For the future, it seems advisable to drive such buses with their own drive in the center of a city, and by supply from overhead wires in the suburbs. Therefore, on reaching the suburbs equipped with overhead wires, the collector must be brought into contact with the wires. This 'wiring up' took place manually with previous current collectors, where, using great manual skill, the sliding collector shoe was brought into contact with the wire, and had to be lined up in the direction of movement of the vehicle. According to the invention, the current collector is provided with additional mechanical arrangements which effect the 'wiring up' of the sliding collector shoe to the wire, and line it up in the direction of movement of the wire. According to the invention, a guiding fork projecting beyond the sliding collector shoe is joined by a linkage to the current collector which forms a surface running parallel to the central collector axis.

12804 Method for the control of the optimal slip frequency of inverter-fed asynchronous A.C. engines. Ansgar, J. (to Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). German(FRG) Patent 2,460,364/A/. 24 Jun 1976. 9p. (In German).

The process described acts to control the optimum slip frequency of inverter-fed asynchronous ac machines for vehicle propulsion, particularly for linear motors. The analog product from the time changes of slip frequency and the propulsive force are used in a control circuit for optimum adjustment. The changeover from motor to generator operation takes place without speed measurement by an impulse signal.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 12798, 12799

FLYWHEEL PROPULSION

12805 (UCRL—52333) **Application of energy storage power systems to nonhighway transportation.** Bolger, J.G.; Epps, R.C.; Jansen, J.F.; Miller, A.B.; O'Connell, L.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 49p. Dep. NTIS, PC A04/MF A01.

The brief summary of nonhighway transportation systems includes a description of the annual energy consumption and duty cycle of each system. The prospects for future energy storage devices are presented and possible applications of energy storage power systems are discussed.

VEHICLE DESIGN FACTORS

REFER ALSO TO CITATION(S) 12800

BODY AND CHASSIS

12806 European standard passenger coaches - from prototype to standard model. Guignard, R.; Weiss, T. (Schweizerische Bundesbahnen (SBB), Yverdon. Hauptwerkstaette). *Z. Eisenbahnwes. Verkehrstech., Glas. Annal.;* **100**: No. 6, 187-191(Jun 1976). (In German).

At present, 500 air-conditioned passenger coaches for international service of largely standardised design are being built for six European railway administrations. The coaches combine different 'national' techniques and experience, their special features being an advanced design of the running gear, access door and power supply. Due to their higher passenger comfort, the coaches are intended as a contribution to making railway services more attractive, particularly in the field of day connections in long-distance traffic.

ENGINE-TRANSMISSION MATCHING

12807 Overdrive for automobiles. Grover, O.P.; Reddy, B.P. (Delhi Coll of Eng, India). *J. Inst. Eng. (India), Mech. Eng. Div.;* **57**: 339-341(May 1977).

An overdrive for a petrol engine and a diesel engine was designed, fabricated and tested for various speed and load conditions. The results indicate an extra mileage of about 12.55% for the petrol engine and 9.2% for the diesel engine.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 12788

12808 Thermodynamic simulation of the diesel engine cycle to show the effect of increasing combustion chamber wall temperatures on thermal efficiency and heat rejection. Griffiths, W.J. *Diesel Eng.;* **73**: No. 793, 82-85(Sum 1977).

Recent articles in the technical press, and discussions among engineers/scientists in industry and research establishments have shown a renewed interest in the use of materials having a very low thermal conductivity for combustion chamber components in diesel engines. The interest appears to stem from an expectation that a significant improvement in fuel economy will result from their use. The primary effect of using low conductivity materials is to increase the combustion chamber wall temperature on the hot-side of the component. This reduces the temperature difference between the gas and the wall, and the heat transferred from the gas to the wall, at least part of this reduction in heat loss should be recoverable as work output, thus increasing the thermal efficiency of the engine. The effect of increasing the piston crown and cylinder heat flameplate temperatures on thermal efficiency and heat rejection for a medium speed turbocharged and intercooled diesel engine is examined using thermodynamic simulation technique.

12809 Recovering energy during braking. Regular town buses with pressure energy storage. Willumeit, H.P. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 14, 13(Apr 1977). (In German).

A system is described with which energy can be recovered during the braking process of vehicles. Connected parallel to the combustion engine is an axial piston unit which can be operated as a hydraulic motor and as a hydraulic pump. The energy is made available by gas pressure storage. When the vehicle is accelerating, the high-pressure storage empties itself, and the pressure energy of the gas is converted into mechanical power in the hydraulic motor. The combustion engine only supplies the power to overcome frictional and air resistance, and to offset efficiency losses. A bus designed on the basis of the system described was developed and subjected to tests. The tests are described.

12810 Optimization of fuel mixture processing. Eisele, H. *VDI (Ver. Dtsch. Ing.) Nachr.;* **31**: No. 14, 14-15(Apr 1977). (In German).

In the processing of fuel mixtures for internal combustion engines for vehicles, fuel injection is gaining in importance. The most probable reason for this may be found in more restrictive legislation on waste gas emissions. There are two different fuel injection systems in use at present: A mechanical system (K-Jetronic), and an electronic system, (L-Jetronic), both marketed by Messrs. Bosch GmbH. Both systems are discussed. The use of either of these fuel injection systems ensures fulfillment of the requirements made by the relevant laws, as well as a more economical fuel consumption.

12811 Study of combustion in compression ignition engines based on the thermodynamic S-log V generalized diagrams. Vichnievsky, R.; Jullien, J.; Ahmed, A.; Leonidze, A. (Univ. Pierre et Marie Curie, Paris). *Entropie;* **13**: No. 74, 8-10, 12-18(1977). (In French).

A new graphical method for analyzing the combustion process in compression ignition engines was developed. This method is based on the use of S-log V generalized diagram for the combustion products at different mixture strengths. Accuracy seems to be sufficient in the graphical calculations. It offers, hence, new possibilities for interpreting data from engine experimentation. For example, it gives very fast estimates of the heat release rates in Diesel engines.

12812 Thermodynamic and aerodynamic evolution of the gaseous mass in a spark ignition transfer engine. Arques, P. (Univ., Paris). *Entropie;* **13**: No. 74, 19-30(1977). (In French).

The analysis of the technological, thermodynamic and aerodynamic phenomena which determine the functioning of a spark ignition transfer engine is based both on an experimental study of the evolution of the physical parameters of the engine and also on the simulation of a mathematical model devised for the purpose of using the knowledge acquired in this way.

12813 Pulse-actuated fuel-injection spark plug. Murray, I.; Tatro, C.A. (to Energy Research and Development Administration). US Patent Application 734,918. 22 Oct 1976. 9p.

A replacement spark plug for reciprocating internal combustion engines that functions as a fuel injector and as a spark plug to provide a "stratified-charge" effect is described. The conventional carburetor is retained to supply the main fuel-air mixture which may be very lean because of the stratified charge. The replacement plug includes a cylindrical piezoelectric ceramic which contracts to act as a pump whenever an ignition pulse is applied to a central rod through the ceramic. The rod is hollow at its upper end for receiving fuel, it is tapered along its lower length to act as a pump, and it is flattened at its lower end to act as a valve for fuel injection from the pump into the cylinder. The rod also acts as the center electrode of the plug, with the spark jumping from the plug base to the lower end of the rod to thereby provide spark ignition that has inherent proper timing with the fuel injection.

12814 Vapipe: a practical system for producing homogeneous gasoline-air mixtures. Harrow, G.A.; Mills, W.D.; Thomas, A.;

Finlay, I.C. Warrendale, PA; Society of Automotive Engineers (1976). 16p. (CONF-760678—26).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

The Vapipe is a device developed to reduce car exhaust emissions and improve fuel economy. It achieves better mixing of the charge entering the engine by vaporizing the gasoline in the inlet system. Heat for this purpose is conveyed from the exhaust system by means of a heat pipe. The heat pipe must be designed to cater for the possibility of gross mismatch between the heat available from the engine exhaust and the heat needed to vaporize the fuel. This can occur under transient conditions of engine operation. Two Vapipe systems were tested, one in which surplus heat from the exhaust is rejected to the cooling system of the car and the second in which the boiler efficiency is varied to maintain the correct flow of heat to the fuel vaporizer. Both systems operate well but the latter is very much cheaper to make than the former. Prototype Vapipes were constructed and tested on test-bed engines, in cars on the road and on chassis dynamometers. The Vapipe provides good mixture distribution and allows the engine to run smoothly at weak mixtures, thus permitting improvements in fuel economy and reductions in exhaust emissions. Substantial benefits were obtained in practical installations, but these could be even greater if carbureters or other fuel-metering devices were developed to take maximum advantage of the homogeneous mixtures. Significant improvements in engine warm-up time, driveability, and flexibility of operation are also achieved but power output is somewhat reduced. Progress was made towards simplifying the design of the Vapipe and making the unit more compact.

12815 Heat pipe early fuel evaporation. Harned, J.L. Warrendale, PA; Society of Automotive Engineers (1976). 12p. (CONF-760678—27).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

Heat pipes for providing early fuel evaporation (EFE) are evaluated. Two design concepts for using heat pipes in the EFE application are described. It was found that a heat pipe can be used as a self-regulating EFE system without direct coupling of intake and exhaust manifolds, at some sacrifice in warm-up rate from that of direct exhaust heat. A 1360 kg car equipped with an emission control system composed of lean mixture carburetion, heat pipe EFE and exhaust gas recirculation achieved emission levels of 0.7 gpm HC, 5.8 gpm CO, 1.7 gpm NO/sub x/ on 1975 Federal Test Procedure with good cold start driveability.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 12814, 12885, 12886

12816 Automatic air-supply-value for the after burning system of the exhaust facility of combustion engines. La Masters, G.D. (to Borg-Warner Corp., Chicago, Ill. (USA)). German(FRG) Patent 1,902,780/C/. 17 Feb 1977. 11p. (In German).

The device is an automatic air-supply valve for the afterburning in the exhaust system of internal combustion engines with a controlling valve element which passes the supplying air coming from a pressure air source to the afterburner.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 12786, 12815

12817 Concentrations of nitrogen oxides in crankcase gases. Spearot, J.A.; Gallopoulos, N.E. Warrendale, PA; Society of Automotive Engineers (1976). 17p. (CONF-760678—25).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

The concentrations of oxides of nitrogen (NO/sub x/ = NO + NO_2) in engine crankcases interest lubricant technologists because NO/sub x/ reactions with fuel and lubricant components are partially responsible for engine deposits and oil deterioration. To provide information hitherto unavailable in the literature, concentrations of NO/sub x/ and NO_2 were measured in the crankcase gas of a multicylinder engine operated at a variety of steady-state conditions. The concentrations of NO/sub x/ and NO_2 measured in the crankcase gas followed the same trends with changes in engine operating variables as the concentrations of NO/sub x/ and NO_2 in the exhaust gas. Specifically, increasing intake manifold pressure, spark advance, and compression ratio, generally increased the concentrations of NO/sub x/ and NO_2. Increasing the percent exhaust gas recirculation, however, decreased NO/sub x/ and NO_2 concentrations. Changing air-fuel ratio (A/F) from rich to lean first increased and then decreased crankcase NO/sub x/ and NO_2 concentrations; the maximum NO/sub x/ and NO_2 concentration occurred at an A/F of about 16. Engine speed affected NO/sub x/ and NO_2 concentrations slightly and inconsistently. Measured NO/sub x/ and NO_2 concentrations in the crankcase gases were in the range 8.7 to 376 and 0.3 to 125 ppM, respectively. Crankcase NO/sub x/ and NO_2 concentrations could not be predicted from those measured in the exhaust gases because the sources of NO/sub x/ and NO_2 are not identical for both crankcase and exhaust gases. Quench gases in the combustion chambers appear to be a significant source of crankcase NO/sub x/, and probably a primary source of crankcase NO_2. Some NO_2 is also formed in the crankcase itself from oxidation of NO.

12818 Heat pipe controlled-temperature combustor for low nitric oxide emissions. Hammond, D.C. Jr.; Mattavi, J.N. Warrendale, PA; Society of Automotive Engineers (1976). 15p. (CONF-760678—28).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

The use of a heat pipe to control nitric oxide formation in the post-flame gases of a continuous-flow combustor was investigated for steady-state conditions. Analytical modeling of such a device predicted that emission levels of nitric oxide formed in the post-flame gases would be several orders of magnitude lower than those associated with an uncontrolled case. The general compatibility of a heat pipe with such a high-temperature environment was demonstrated by exposing a sodium heat pipe to a propane-air flame for 1000 hours with no measurable degradation in performance. The quantity of nitric oxide formed in the flame front may be substantial in some combustors and is not amenable to reduction by the heat pipe concept of this study. Transient operation is another potential problem area for vehicular applications of the study combustor.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 12786, 12815

12819 Effects of phosphorus-containing engine oil additives on exhaust oxidation catalyst degradation. Caracciolo, F.; Spearot, J.A. Warrendale, PA; Society of Automotive Engineers (1976). 14p. (CONF-760678—24).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

Catalyst deterioration caused by phosphorus-containing engine oil additives was investigated using a variety of engine oil blends in a steady-state engine-dynamometer test. The reductions in hydrocarbon and carbon monoxide conversion in the 200-hour test were related to two parameters: (1) the quantity of phosphorus in the oil added to the engine, and (2) the amount of phosphorus on the catalyst at the end of the test. Catalyst degradation relative to the first parameter differed from that relative to the second because the two parameters were not directly related. Specifically, catalyst conversion efficiency decreased nonlinearly with the amount of oil-derived phosphorus added to the engine, but linearly with the amount of oil-derived phosphorus found on the catalyst. A higher percentage of phosphorus added to the engine was found on the catalyst with oils containing tricresylphosphate (TCP) than with oils containing zinc dialkyldithiophosphate (ZDP). For a fixed amount of phosphorus on the catalyst, however, oils containing ZDP were more harmful to catalyst performance than oils containing TCP. For most oils containing ZDP, phosphorus was observed to accumulate in sump oil during engine operation. As a result, less phosphorus than that added to the engine was responsible for the decrease in catalyst conversion efficiencies observed with these oils.

HYDROCARBONS

REFER ALSO TO CITATION(S) 12786, 12815, 12819, 12821

ALTERNATIVE FUELS

12820 (AD—728305) **Chemical and physical study of fuels gelled with hydrocarbon resins. Final report, June 22, 1970—February 2, 1971.** Erickson, R.E.; Krajewski, R.M. (Dow Chemical Co., Midland, Mich. (USA)). Jul 1971. 106p. (FAA-RD—71-34). NTIS.

A gelled fuel was modified to achieve low viscosity at low shear while maintaining significant resistance to fire while in the misting condition. The modified gelled fuel was rheologically profiled using a variety of rheometers. Test data on flowability, rheological characteristics, and simulated crash fire misting hazard are included.

12821 (CONS/1011—20) **Performance and emissions of a catalytic reactor with propane, diesel, and Jet A fuels.** Anderson, D.N. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1977. Contract EX-76-A-31-1011. 9p. (CONF-771015—5; NASA-TM—73786). Dep. NTIS, PC A02/MF A01.

From Fall meeting of the Western States Section of the Combustion Institute; Palo Alto, CA, USA (17 Oct 1977).

As part of the ERDA-funded Gas Turbine Highway Vehicle Systems project, tests were made to determine the performance and emissions of a catalytic reactor operated with propane, No. 2 diesel, and Jet A fuels. A 12-cm diameter and 16-cm long catalytic reactor using a proprietary noble metal catalyst was operated at an inlet temperature of 800 K, a pressure of 3 x 10^5 Pa and reference velocities of 10 to 15 m/s. No significant differences between the performance of the three fuels were observed when 98.5% purity propane was used. The combustion efficiency for 99.8% purity propane tested later was significantly lower, however. The diesel fuel contained 135 ppM of bound nitrogen and consequently produced the highest NO/sub x/ emissions of the three fuels. As much as 85% of the bound nitrogen was converted to NO/sub x/. Steady-state emissions goals based on half the most stringent proposed automotive standards were met when the reactor was operated at an adiabatic combustion temperature higher than 1350 K with all fuels except the 99.8% purity propane. With that fuel, a minimum temperature of 1480 K was required.

12822 New look at multigraded diesel engine oils. Smith, M.F. Jr.; Tunkel, N.; Bachman, H.E.; Fernandez, W.J. Warrendale, PA; Society of Automotive Engineers (1976). 14p. (CONF-760678—22).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

Benefits for multigraded oils developed for diesel engine service were found in performance areas such as low temperature engine cranking/starting, oil consumption rate, bearing wear, and fuel economy in stop-and-go service. Studies continue to indicate that multigraded diesel engine oils should be formulated with a minimum amount of pure polymer, consistent with desired viscometric targets, in order to minimize piston deposit formation. Premium multigraded, extended drain lubricants depend upon modern viscosity improver technology coupled with improved detergent-inhibitor additive technology.

12823 Maximizing petroleum utilization through extension of passenger car oil drain periods: what's required. Gergel, W.C.; Sheahan, T.J. Warrendale, PA; Society of Automotive Engineers (1976). 12p. (CONF-760678—23).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

A study was made of passenger car engine oil drain intervals from 1946 to the present time. The drain intervals were intercompared with engine tests used to gauge oil performance and trends in automotive emission control. Preliminary data from vehicle tests show that the technology may be available to achieve longer drain intervals in today's automobiles. With the stipulation that the extended drain capabilities of an oil formulation must be qualified in relation to the type of service and the type of gasoline used (i.e., leaded or unleaded fuel), taxicab data show that higher quality levels then current API SE are needed to double today's recommended oil change intervals. Engine wear appears to be the major technical limitation on extending oil change intervals. Other technical limitations are control of engine deposits and resistance to oil thickening.

12824 Hydrogen storage in vehicles: an operational comparison of alternative prototypes. Woolley, R.L.; Simons, H.M. Warrendale, PA; Society of Automotive Engineers (1976). 10p. (CONF-760678—30).

From Meeting of the Society of Automotive Engineers on combined fuels and powerplant; St. Louis, MO, USA (8 Jun 1976).

Performance and operational characteristics of several prototype containers for storing hydrogen are described. A cryogenic vessel and three metal hydride containers of similar design but different size were used in automotive service. Hydrogen release rates were controlled to match with engine demand. All prototypes were able to sustain a steady state flow rate sufficient for vehicle operation at normal cruise speed. In order to illustrate the principle of hydride operation, a pressure—temperature history for recharge of a small portable hydride tank is given along with several discharge curves with and without heating.

MATERIALS

REFER ALSO TO CITATION(S) 11410

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 11442

12825 (TID—2334-S3) Sodium technology, January 1975—June 1976. (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Aug 1977. 216p. Dep. NTIS, PC A10/MF A01.

References to 1129 publications on sodium and NaK technology cited in Nuclear Science Abstracts Volume 31 through Volume 33 are contained in this bibliography. References are arranged in order by the original NSA abstract number which approximately places them in chronological order. Sequence numbers appear beside each reference, and the indexes refer to these sequence numbers. Subject descriptors are included to reflect the information content of each article.

12826 Powder metallurgy in defense technology. Volume 3. Princeton, NJ; Metal Powder Industries Federation (1977). 206p. (CONF-7510178—; CONF-7604142—).

From Proceedings of two P/M in ordnance seminars held at the Picatinny Arsenal; Dover, NJ, USA (8 Oct 1975).

Topics in powder metallurgy fabrication by forging, sintering and pressing are covered along with applications of powder metal components in ordnance. Physical properties and microstructure studies are presented. (GHT)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 12378, 12740, 12955, 12957

12827 (IBK—1398) Quality assurance and certification of zirconium alloy fuel cladding materials in out of reactor condition. Jovasevic, J.; Stefanovic, V.; Spasic, Z. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1976. 20p. (In Serbian). Dep. NTIS (US Sales Only), PC A02/MF A01.

Basic characteristics of UO_2 fuel - metal cladding are given. Standard specifications for Zr and ZR alloy seamless and welded tubes for nuclear service, standard methods and recommended practices of the quality control of these materials are proposed.

12828 Mold with improved core for metal casting operation. Gritzner, V.B.; Hackett, D.W. (to Energy Research and Development Administration). US Patent 4,032,105. 28 Jun 1977. Filed date 25 Apr 1975. 4p.

PAT-APPL-571,445.

The present invention is directed to a mold containing an improved core for use in casting hollow, metallic articles. The core is formed of, or covered with, a layer of cellular material which possesses sufficient strength to maintain its structural integrity during casting, but will crush to alleviate the internal stresses that build up if the normal contraction during solidification and cooling is restricted.

12829 Method of melting metals to reduce contamination from crucibles. Banker, J.G.; Wigginton, H.L. (to Energy Research and Development Administration). US Patent 4,028,096. 7 Jun 1977. Filed date 13 May 1976. 6p.

PAT-APPL-686,447.

Contamination of metals from crucible materials during melting operations is reduced by coating the interior surface of the crucible with a ceramic non-reactive with the metallic charge and disposing a metal liner formed from a portion of the metallic charge within the coated crucible. The liner protects the ceramic coating during loading of the remainder of the charge and expands against the ceramic coating during heat-up to aid in sintering the coating. 5 claims, 1 figure.

12830 Semicold and hot working of titanium alloys and high-temperature resistant materials. Turlach, G. (Kamax-Werke Rudolf Kellermann G.m.b.H., Osterode (Germany, F.R.)). *VDI (Ver. Dtsch. Ing.) Ber.;* No. 266, 121-130(1976). (In German). (AED-Conf—76-673-001).

From Conference on coldworking; Mannheim, Germany, F.R. (10 Nov 1976).

When working high-temperature resistant materials, structural changes are caused which affect the mechanical properties. The problems connected with these changes are discussed using the example of set screws made of the titanium base alloy Ti-6Al-4V and the nickel base alloys nimonic 80 and waspaloy. The influence of working, working temperature and heat treatment on the structure is shown. The engineer is faced with the problem of choosing the type of working and the appropriate temperature in such a way that the desired structural state is maintained and the mechanical properties of the material may be fully utilized.

12831 Heat treatment, microstructure, and mechanical properties of experimental high strength Fe—4Cr—0.4C steels. Narasimha Rao, B.V.; Miller, R.W.; Thomas, G. pp 75-85 of In Heat treatment 1976. London; Metals Society (1976).

From 16. international heat treatment conference; Stratford-upon-Avon, England (6 May 1976).

As part of a continuing experimental program on alloy design of structural steels, the present investigation is concerned with the heat treatment, microstructure, and mechanical properties of martensitic and lower bainitic Fe—4Cr—0.4C steels which are normally

brittle after conventional treatments. New double heat treatments have been designed in order to avoid intergranular cracking in the as-quenched structures and to take advantage of both a higher austenitizing temperature and fine austenite grain size. These treatments involve high-temperature (1100°C) austenitizing during the first solution treatment followed by either interrupted quenching (M/sub s/—M/sub f/ range) or isothermal transformation to produce lower bainite. Finally, the steels are given a 900°C grain-refinement treatment. Lower bainite was obtained by isothermally transforming austenite just above the M/sub s/ temperature. Tempering after the martensitic and bainitic treatments was also done in an attempt to improve the toughness of the material. The strength and toughness properties of as-quenched martensitic structures are somewhat superior while these properties of lower bainitic structures are comparable to those of a plain 0.4 percent C steel. The properties of the nearly 100 percent bainite structure were unaffected by the cooling rate from the transformation temperature. Elimination of intergranular cracking produced toughness properties in quenched and tempered martensites which are far superior to those of lower bainite at the same strength level. It has also been shown that the toughness properties of as-quenched double-treated steels are superior to single-treated steels. The chromium appeared to have a strong influence on the nature and morphology of carbides, as the bainitic as well as the martensitic structures showed marked temper resistance in the tempering range 200° to 500°C.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 12841

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 12354, 12831

12832 (BLG—517) **Oxide dispersion-strengthened ferritic alloys. DTO_2 data sheet.** van Asbroeck, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Oct 1976. 6p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The publication gives the available data on the DTO2 dispersion-strengthened ferritic alloy developed at C.E.N./S.C.K. Mol, Belgium. DTO2 is a Fe-Cr-Mo ferritic alloy, strengthened by addition of titanium oxide and of titanium leading to the formation of Chi phase. It was developed for use as canning material for fast breeder reactors.

12833 (BLG—518) **Oxide dispersion-strengthened ferritic alloys. Dy data sheet.** van Asbroeck, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Oct 1976. 6p. Dep. NTIS (US Sales Only), PC A02/MF A01.

This publication gives the available data on the DY dispersion-strengthened ferritic alloys developed at C.E.N./S.C.K. Mol, Belgium. DY is a Fe-Cr-Mo ferritic alloy, strengthened by addition of yttrium oxide and of titanium leading to the formation of Chi phase: it was developed for use as canning material for fast breeder reactors.

12834 (CEGB-RD/B/N—4017) **Fatigue crack length measurement system for materials immersed in high temperature liquid sodium environments.** Priddle, E.K.; Wiltshire, C. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Apr 1977. 10p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A fully developed system is described for measuring fatigue crack growth in materials test pieces immersed in high temperature liquid sodium. An outline of the principles on which the system is based is described together with component and operational details of the various parts.

12835 Effect of temperature upon fatique crack growth behavior in Nimonic PE16. James, L.A. (Westinghouse Hanford Co., Richland, Wash. (USA)); Spear, W.S. (Washington Univ., Seattle (USA)). *J. Nucl. Mater.;* **67**: No. 3, 283-288(Aug 1977).

The techniques of linear-elastic fracture mechanics were employed to characterize the effect of temperature upon the fatigue-crack propagation behavior of Nimonic PE16 in an air environment over the range 24-649°C. In general, crack growth rates increased with increasing test temperature. Curves of log(da/dN) versus log(ΔK) were generally sigmoidal in shape and in general did not obey a simple linear power law.

12836 Use of pole figure data to compute elasticity coefficients of zirconium sheet. Rosenbaum, H.S. (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.); Lewis, J.E. (General Electric Co., Pleasanton, Calif. (USA). Vallecitos Nuclear Center). *J. Nucl. Mater.;* **67**: No. 3, 273-282(Aug 1977).

The elastic coefficients of polycrystalline zirconium can be computed by combining the known coefficients of zirconium monocrystals with pole figure data as measured by X-ray diffraction. The method uses a space average of the monocrystals compliance coefficients, weighted by the crystallographic pole density. The method is applicable to commercial Zircaloy giving the anisotropy of the elastic properties. This analysis and method provide all of the compliance coefficients needed for a complete solution of the generalized Hooke's Law equation for product forms with orthotropic symmetry (e.g. rolled sheet). It approximates a complete solution for thin-walled tubes. Sufficient monocrystal data exist for calculation of elastic properties over a range of temperatures.

12837 Review of mechanical behavior and stress effects in hard superconductors. Koch, C.C.; Easton, D.S. (Oak Ridge National Lab., Tenn. (USA)). *Cryogenics;* **17**: No. 7, 391-413(Jul 1977).

The mechanical properties of type II superconducting materials are reviewed as well as the effect of stress on the superconducting properties of these materials. The bcc alloys Nb-Ti and Nb-Zr exhibit good strength and extensive ductility at room temperature. Mechanical tests on these alloys at 4.2 K revealed serrated stress-strain curves, non-linear elastic effects, and reduced ductility. The non-linear behaviour is probably due to twinning and de-twinning or a reversible stress-induced martensitic transformation. The brittle A-15 compound superconductors, such as Nb_3Sn and V_3Ga, exhibit unusual elastic properties and structural instabilities at cryogenic temperatures. Multifilamentary composites consisting of superconducting filaments in a normal metal matrix are normally used for superconducting devices. The mechanical properties of alloy and compound composites, tapes, as well as composites of niobium carbonitride chemically vapor deposited on high strength carbon fibres are presented. Hysteretic stress-strain behavior in the metal matrix composites produces significant heat generation, an effect which may lead to degradation in performance of high field magnets. Measurements of the critical current density, J/sub c/, under stress in a magnetic field are reported. Modest stress-reversible degradation in J/sub c/ is observed in Nb-Ti composites, while more serious degradation is found in Nb_3Sn samples. The importance of mechanical behavior on device performance is discussed.

12838 Mechanical property correlations for 21/4 Cr—1 Mo steel in support of nuclear reactor systems design. Booker, M.K.; Hebble, T.L.; Hobson, D.O.; Brinkman, C.R. (Oak Ridge Natl Lab, Tenn). *Int. J. Pressure Vessels Piping;* **5**: No. 3, 181-205(Jul 1977).

A large collection of mechanical properties data for this material has been compiled from the literature and from private sources. Analysis of these data has yielded mathematical descriptions of the tensile, creep, fatigue and impact properties of annealed and isothermally annealed 21/4 Cr—1 Mo steel. Where appropriate, statistical analysis has been performed to yield estimates of possible variations in behavior. The final results represent a comprehensive description of the mechanical behavior of the material. This description makes a substantial contribution to the characterization required for use of 21/4 Cr—1 Mo steel in the construction of nuclear systems.

12839 Near-threshold fatigue crack propagation in ultra-high strength steel: influence of load ratio and cyclic strength. Ritchie, R.O. (Massachusetts Inst. of Tech., Cambridge). *J. Eng. Mater. Technol.;* **99**: No. 3, 195-204(Jul 1977).

Fatigue crack propagation behavior of an ultra-high strength steel (300-M) has been investigated in humid air over a very wide spectrum of growth rates from 10^{-8} to 10^{-1} mm/cycle. Particular emphasis has been devoted to the influence of mean stress (or load ratio R = K/sub min//K/sub max/) and microstructure on fatigue crack growth near the threshold stress intensity for crack propagation, ΔK_0. Increasing the load ratio from R = 0.05 to 0.70 was found to lead to increased near-threshold growth rates, and a decrease in the threshold stress intensity. Similarly, increasing material strength, by varying the microstructure through quench and tempering and isothermal transformation, resulted in higher near-threshold growth rates, and a marked reduction of ΔK_0. These effects are contrasted with behavior at higher growth rates. The infuence of strength on ΔK_0 is rationalized in terms of the cyclic hardening or softening response of the material, and hence it is shown that cyclic softening can be beneficial to fatigue crack propagation resistance at very low growth rates. The results are discussed in the light of crack closure and environmental contributions to fatigue crack growth at low stress intensities.

12840 Fatigue crack propagation in types 304 and 308 stainless steel at elevated temperatures. Raske, D.T.; Cheng, C.F. (Argonne Natl Lab, Ill). *Nucl. Technol.;* **34**: No. 1, 101-110(Jun 1977).

The fatigue crack-growth behavior of Type 304 stainless-steel base metal and Type 308 stainless-steel weld metal at elevated temperature was investigated using axially loaded single-edge-notch specimens. The crack-growth rates were determined and are presented as a function of the stress-intensity factor range. Both the base- and weld-metal specimens were tested in the as-received (or as-welded) and thermally aged condition. The results indicate that the crack-growth rates in the weld metal are significantly lower than in the base metal. In addition, aging at 593°C for 1000 h improved the resistance to fatigue crack growth in both the base and weld metals.

These results are relevant to austenitic stainless steels fabricated by welding for use in liquid-metal fast breeder reactors.

12841 High strength, high ductility low carbon steel. Koo, J.; Thomas, G. (to Energy Research and Development Administration). US Patent Application S47,901. 1977. 17p.

A high strength, high ductility low carbon steel consisting essentially of iron, 0.05—0.15 wt% carbon, and 1—3 wt% silicon. Minor amounts of other constituents may be present. The steel is characterized by a duplex ferrite-martensite microstructure in a fibrous morphology. The microstructure is developed by heat treatment consisting of initial austenitizing treatment followed by annealing in the ($\alpha + \gamma$) range with intermediate quenching.

12842 High velocity tensile test of austenitic stainless steel at elevated temperature. Tensile test of JIS SUS 304 steel parent metal. Isozaki, T.; Ueda, S.; Oba, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nippon Kikai Gakkai Rombunshu;* **42**: No. 359, 2034-2041(Jul 1976). (In Japanese).

One of the subjects concerning the safety protection of engineering facilities in the FBR being developed is the dynamic response of reactor structures to shock load, such as the pressure wave arising in nuclear runaway accident. When the dynamic analysis of structures is carried out by taking large plastic deformation into account, the effect of strain rate on the mechanical properties of structural materials must be clarified in order to secure the accuracy of analysis and to decide the soundness of the structures to the obtained deformation. A high-temperature, high velocity tensile testing machine directly utilizing the explosive power of blasting powder was manufactured by the authors, and the high velocity tensile test of SUS 304 steel at room temperature, 400 deg and 600 deg C was carried out, using the amount of explosive as a parameter. A simple pulse type displacement meter was devised by the authors, and the deformation of test pieces was able to be successfully measured from time to time. The range of strain rate obtained was from 80/sec to 1300/sec at the time of tensile strength, and the strain rate increased with the amount of explosive. The 0.2% proof stress increased by 70% in high velocity test as compared with that of static test. The elongation in high velocity test was larger than that in static test. The deformation energy up to rupture in high velocity test was larger than that in static test.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 11634, 11804, 12832, 12833, 13524

12843 Density and temperature dependence of the surface tension of molten bismuth, lead, and bismuth-lead alloys. Abdel-Aziz, A.H.K.; Kirshah, M.B. (Alexandria Univ. (Egypt). Faculty of Engineering). *Z. Metallkd.;* **68**: No. 6, 437-439(Jun 1977).

The density and the temperature dependence of the surface tension of molten bismuth, lead, and bismuth-lead alloys were studied in the temperature range 623 to 953K, using a maximum bubble pressure apparatus. In the temperature range covered, the mean density of bismuth is 10,031 kg/m^3 and that of lead is 10,530 kg/m^3. The surface tension of bismuth decreases from 0.379 N/m at 653K to 0.359 N/m at 953K, while that of lead decreases from 0.451 N/m at 633K to 0.409 N/m at 923K. The densities of the alloys and the surface tension isotherms are all below the corresponding additive straight lines.

12844 Central peaks and soft modes in praseodymium. Houmann, J.G.; Lebech, B.; Mackintosh, A.R. (Danish Atomic Energy Commission, Risoe. Research Establishment); Buyers, W.J.L. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.); McMasters, O.D.; Gschneidner, K.A. Jr. (Ames Lab., Iowa (USA)). *Physica, B, C;* **86-88**: 1156-1157(Jan-Mar 1977).

From International conference on magnetism; Amsterdam, Netherlands (6 Sep 1976).

The dhcp allotrope of Pr is a singlet ground-state system which is very close to magnetic ordering at low temperatures. Quasi-elastic magnetic scattering has been observed around the q-value in the (100) directions at which the dispersion relations for the magnetic excitations have a minimum energy. The excitations were measured along all symmetry lines in the zone, and the dependence of the energies and lifetimes on the temperature and magnetic field was investigated.

12845 Low temperature specific heat of $NpOs_2$ and $NpRu_2$. Brodsky, M.B.; Trainor, R.J. (Argonne National Lab., Ill. (USA)). *Physica, B, C;* **86-88**: 143-144(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

Specific heat measurements on $NpOs_2$ show a peak at T/sub c/=7.9+-0.1 K, and γ=90 mJ/(mol K^2) above T/sub c/. The magnetic entropy, 0.2 R ln 2, supports previous arguments for itinerant ferromagnetism. The data for $NpRu_2$, supposedly a spin fluctuation compound, are fit below 10 K by $C/T=\gamma+BT^2$, with γ=118 mJ/(mol K^2) and B corresponding to theat/sub D/=174 K.

12846 Anisotropic conduction-electron exchange in dilute rare-earth alloys: NMR in $Au^{173}Yb$ and $La^{31}PCe$. Follstaedt, D.M.; Meyer, W.J.; Narath, A. (Sandia Labs., Albuquerque, N.Mex. (USA)). *Physica, B, C;* **86-88**: 507-508(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

Two experiments are reported requiring an anisotropic exchange interaction for their interpretation. Nuclear relaxation rates in $Au^{173}Yb$ at 1.0 K and fields to 120 kOe are shown to arise from local-moment fluctuations within the $GAMMA_7$ groundstate, contributions from excited crystal-field levels being unimportant. Nearest-neighbor satellite resonance shifts in LaPCe are not proportional to the Ce^{3+} susceptibility above 26 K.

12847 Electronic structure and properties of the actinides. Freeman, A.J. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Physics); Koelling, D.D. (Argonne National Lab., Ill. (USA)). *Physica, B, C;* **86-88**: 16-25(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

The authors review the present state of understanding of the electronic structure and physical properties of actinide metals and intermetallic compounds as derived from relativistic APW energy band studies of some of the light (Th, U, Np and Pu) and heavy (Am, Bk and Cm) metals, the intermetallics URh_3 and UIr_3 and (NaCl structure compounds such as) UC. Emphasis is placed on the importance of Coulomb correlation and the role of actinide-actinide separation in determining the itinerancy (as in the light metals) or localization (as in the heavy metals) of the 5f electrons and in turn their resulting magnetic and other properties. The UX_3 systems considered are significant because the uranium sites are sufficiently separated to fall in the local moment f orbital range of the Hill superconductivity/magnetism plot but show no magnetic ordering. Comparisons to recent optical, de Haas-van Alphen and other data are given when available. The contrasting cases of the transition and rare-earth systems make it clear that the 5f electrons are a unique species which offer exciting challenges to both experimentalists and theorists.

12848 Determination of cobalt behavior in $TmCo_2$ and $HoCo_2$ by means of polarized neutron diffraction. Gignoux, D.; Givord, F. (Centre National de la Recherche Scientifique, 38 - Grenoble (France). Lab. de Magnetisme); Koehler, W.C. (Oak Ridge National Lab., Tenn. (USA)). *Physica, B, C;* **86-88**: 165-166(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

The determination, from polarized neutron diffraction measurements, of the Co moment in $HoCo_2$ and $TmCo_2$ at various temperatures shows that the Co paramagnetic susceptibility is of Pauli type. Below the ordering temperature a large increase of the Co susceptibility, related to the large value of the molecular field, is observed.

12849 Magnetic properties of the $AnFe_2$ compounds (An = U, Np, Pu, and Am). Lander, G.H.; Aldred, A.T.; Dunlap, B.D.; Shenoy, G.K. (Argonne National Lab., Ill. (USA)). *Physica, B, C;* **86**: No. 88, 152-154(1977).

From International conference on magnetism; Amsterdam, The Netherlands (6 - 10 Sep 1976).

The magnetic properties of the actinide Laves compounds (cubic C-15 crystal structure) with iron have been studied by magnetization, neutron diffraction, and Moessbauer-effect techniques. All the compounds exhibit a spontaneous magnetization. Magnetic moments of 0.06, 1.09, 0.45, and -0.4 μ/sub B/ are associated with the U, Np, Pu and Am ions, respectively. The corresponding iron moments are 0.6, 1.4, 1.5, and 1.7 μ/sub B/. The ferrimagnetic nature of $AmFe_2$ suggests a partial occupancy of the Am^{2+}:f^7 state, inasmuch as the Am^{3+}:f^6 state has a nonmagnetic ground state.

12850 Field induced magnetic density in the paramagnetic compound $LuCo_2$. Gignoux, D.; Givord, F. (Centre National de la Recherche Scientifique, 38 - Grenoble (France)); Koehler, W.C.; Moon, R.M. (Oak Ridge National Lab., Tenn. (USA)). *J. Magn. Magn. Mater.;* **5**: No. 2, 172-175(1977).

The magnetization density induced in $LuCo_2$ by an applied magnetic field was measured by means of polarized neutron diffraction. The measurements were performed on a single crystal at 100 K in an applied field of 57.2 kOe. The observed density is localized on Co atoms with a form factor which is, within the experimental accuracy, similar to that of 3d electrons in Co metal. Weak additional magnetic amplitudes reveal a nonuniform polarization of the conduction band. Its mean value is opposite to the Co moment as in Co metal.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 11433, 11637, 11923, 12048, 12771, 13001

12851 Some observations on the compatibility of structural materials with molten lead. Asher, R.C.; Davies, D.; Beetham, S.A. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). *Corros. Sci.;* **17**: No. 7, 545-557(1977).

Exploratory experiments have been carried out relating to the use of molten lead as a coolant in advanced nuclear reactors. It has been found that the attack of molten lead on structural materials is qualitatively related to the solubility of the solid in the lead. The attack can be greatly reduced by the presence of a protective oxide film on the solid, and the ease of formation of such a film depends on the nature of the solid and the oxidizing potential of the lead. The effectiveness as an 'inhibitor' of titanium dissolved in the lead has been confirmed. Mass transfer has been shown to be very inefficient, at least under the experimental conditions used, and reasons for this are discussed. A number of ceramic materials have been shown to be very resistant. A cast iron exhibited 'growth'. With two exceptions a range of coated materials showed unsatisfactory behaviour. An exploratory experiment on the susceptibility of molybdenum to liquid metal embrittlement did not result in failure of the specimen.

12852 Compatibility of FBR component materials with high temperature sodium. Atsumo, H.; Kano, S.; Yuhara, S.; Maruyama, A. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Genshiryoku Kogyo;* **22**: No. 9, 47-54(Sep 1976). (In Japanese).

The exposure of stainless steels and chromium-molybdenum steels to high temperature sodium was studied. The daughter loops of low purity material test loop (sodium purity of 10 ppm oxygen) and of medium purity material test loop (sodium purity of 5 ppm oxygen) were used for the experiments. These loops were generally made of austenitic stainless steels, and the surface materials in contact with sodium are 304 SS and 316 SS. The cold trap temperatures were set at 190 deg C and 145 deg C, respectively. The oxygen concentrations in sodium corresponding to the temperatures of these cold traps were about 10 ppm and 5 ppm, respectively. The mass transfer test was performed by circulating sodium purified in the mother loops. The experiments revealed that both austenitic steels and 2—1/4Cr—1Mo steel showed slight overall corrosion on the exposed surfaces of the high temperature hot legs, and 316 SS produced micro-voids near such corroded surfaces. The weight of stainless steels at the hot legs increased in the range of low temperature and decreased in the range of high temperature, and the weight of 2-1/4Cr—1Mo steel descreased in the whole range of temperature. As the oxygen concentration of Reynolds number of sodium flow increased, the corrosion rate of all kinds of steels increased. The corrosion rate was influenced by cold working and heat treatment. Decarbonization of 316 SS occurred only at high temperature hot legs, and that of 2-1/4Cr—1Mo steel, in the whole range of both hot and cold legs.

12853 Hydrogen brittleness of 15Kh3MFA steel under irradiation and some problems of the reliability of the housings of water cooled reactors without anticorrosion protection. Alekseenko, N.N.; Kuznetsov, A.A.; Nikolaev, V.A.; Razov, I.A.; Usatov, E.P. pp 68-77 of In V sb. radiatsion. effekty izmeniya mekh. svoystv konstrukts. materialov, i metody ikh issled. Kiev; Naukova Dumka (1976). (In Russian)

The housings of the water cooled, water moderated nuclear reactors of the Soviet Atomic Electric Power Plants are made of low alloy 15Kh3MFA steel. The basic sources of hydrogen in the water cooled nuclear reactor system are presented. The presented results of the studies performed on 15Kh3MFA steel (0.14 percent C, 0.26 percent Si, 0.44 percent Mn, 0.019 percent S, 0.012 percent P, 3.0 percent Cr, 0.76 percent Mo and 0.31 percent V) indicate that the neutron irradiation essentially changes its corrosion resistance, absorption capacity and the diffusion mobility of the hydrogen in the metal. As a result of the experiments performed it turned out that the neutron irradiation inhibits the recovery of ductility of the hydrogen-charged steel. The recovery of the ductility of hydrogen charged steel after irradiation at a temperature of 300 to 350°C coincides with the complete degassing of the metal. In a number of cases the reduction of the ductility is accompanied by a decrease in strength which with the hydrogen content of 4 to 5 cm^3 per 100 grams of metal can reach 19 kg-force/mm^2. An estimate of the effect of the neutron irradiation on the inclination toward slow destruction of 15Kh3MFA steel under the effect of hydrogen was performed on cylindrical rupture samples with an annular notch after irradiation with a dose of 10^{20} neutrons/cm^2 at a temperature of 300 to 350°C. The tests were performed on the devices with spring loading for continuous cathode hydrogen charging in a 5 percent solution of sulfuric acid. 17 references.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 12231, 12428, 13524, 13551

12854 (EURFNR—1465) Importance and status of (n,α)-cross sections for a reliable prediction of radiation damage in stainless steel. Goel, B. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jun 1977. 29p. (KFK—2473). Dep. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States—Euratom Fast REactor Exchange Program.

It is well established that helium formed in stainless steel by various (n,α) processes has a pronounced effect on its mechanical and dimensional properties. There has been strong discrepancy between the helium contents measured in irradiated stainless steel and that calculated on the basis of known (n,α) cross sections on the stable constituents of stainless steel. This discrepancy seems to be resolved by attributing the excessive helium to the two-step process $^{58}Ni(n,\gamma)^{59}Ni(n,\alpha)^{56}Fe$. However, a large discrepancy exists between the value of the thermal cross section for the $^{59}Ni(n,\alpha)^{56}Fe$ process used to calculate the helium production data and that obtained from the direct measurements of this cross section. The role of the (n,α) cross section on the irradiation-induced swelling is investigated. It is shown that insoluble gases like helium do influence swelling by way of nucleating and stabilizing voids. It is further shown that helium produced via ^{59}Ni constitutes a substantial amount of helium produced in stainless steel under thermal as well as under fast reactor conditions. In fast reactors helium produced via ^{59}Ni gains its importance at high neutron fluences. A linear extrapolation of helium production data measured at low fluences to the fluences of the order of 1.5×10^{23} n/cm^2 is not justified. It is shown that the usual practice to relate helium production data to thermal and fast neutron fluence is inadequate. The details of neutron spectrum are necessary to predict helium production rate reliably. A measurement of $^{59}(n,\alpha)^{56}Fe$ cross section in keV range is recommended. 8 figures, 4 tables.

12855 (KFTI—75-35, pp 8-25) Charge-particle beam studies and simulation of some phenomena in nuclear- and fusion reactor materials. Zelenskii, V.F.; Ivanov, V.E.; Matvienko, B.V. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1975. (In Russian).

In Nuclear science and engineering problems.

The possibilities of charged-particle beams, in particular high-energy electron radiation, for simulation and study of reactor radiation effects are analysed. The results are provided of investigations of the high-temperature radiation embrittlement and oxidation of nickel and steel OKh16N15M3B upon electron irradiation, and swelling of nickel and nickel-scandium alloys upon irradiation by nickel and helium ions. The action of 8MeV and 225MeV electron radiation on the mechanical properties of nickel is studied, and the comparison of data obtained with those on the strengthening after the irradiation in a reactor is made.

CERAMICS, CERMETS, AND REFRACTORIES

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 11719, 11720, 11725

12856 Hot pressing large diameter PLZT electrooptic ceramics. Dungan, R.H.; Snow, G.S. (Sandia Labs., Albuquerque, NM). *Am. Ceram. Soc. Bull.;* **56**: No. 9, 781-782(Sep 1977).

The fabrication of optical quality 13-cm diameter La-modified lead zirconate-titanate (PLZT) ceramics for use as the active electrooptic elements in thermal and flashblindness protective windows for aircrew protection was investigated.

12857 Boron nitride insulating material. Morgan, C.S. Jr.; Cavin, O.B.; McCulloch, R.W.; Clark, D.L. (to Energy Research and Development Administration). US Patent Application 744,494. 24 Nov 1976. 16p.

High temperature boron-nitride-insulated heaters for use as fuel pin simulators in reactor thermal hydraulic test facility studies are fabricated by a method of cold pressing boron nitride preforms which are inserted within the heater housing and crushed in place. The heaters may then be deformed to increase the BN density and provide better thermal contact with the heating element and the housing. BN insulation provided by crushing the preforms retains preferred particle orientation and provides higher, more uniform thermal conductivity.

12858 Process for diffusing metallic coatings into ceramics to improve their voltage withstanding. Miller, H.C.; Zuhr, H.F. (to Energy Research and Development Administration). US Patent Application 740,339. 9 Nov 1976. 6p.

A method for diffusing metallic coatings into ceramic insulators to improve their voltage withstanding capabilities is described.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 11718, 11724

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 11430, 12856

12859 (CIT—767P15X1) **Study of metal hydrides with multiple pulse nuclear magnetic resonance techniques. Annual progress report, June 1, 1976—May 31, 1977.** Vaughan, R.W. (California Inst. of Tech., Pasadena (USA). Div. of Chemistry and Chemical Engineering). 1977. Contract EY-76-S-03-0767-015. 10p. Dep. NTIS, PC A02/MF A01.

An administrative summary of work on metal hydrides like Th_4H_{15} and the covalently bonded hydride complexes $Ru_4H_4(CO)_{12}$, $Os_4H_4(CO)_{12}$, and $Os_3H_2(CO)_{10}$ is given. The motion of fluoride ions in difluorides and the NMR examination of β and β'' aluminas (of importance as solid-state electrolytes in Na/S battery systems and in sodium heat engines) are also under investigation. (RWR)

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 11430

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 12212

COMPOSITE MATERIALS

PHYSICAL PROPERTIES

12860 (ORNL-tr—4458) **Thermal diffusivity of concrete as a composite material.** Tokuda, H.; Shoya, M. Translated by H. Kubota from *Zairyo;* **21**: No. 230, 1017-1023(1972). 10p. Dep. NTIS, PC A02/MF A01.

Concrete can be regarded as a composite material composed of cement paste or mortar as a matrix and gravel as an aggregate. Thermal diffusivity is a measure of material's ability to undergo a temperature change. In this study, the thermal diffusivity of concrete was measured and the results were examined from the viewpoint of a composite material. When both of the fine and the coarse aggregates are of the same rock type, the diffusivity of the concrete shows a tendency to increase with increasing the aggregate content. When they are different, however, such tendency no longer exists. Hence the rock type is one of the most important factors which determine the diffusivity of concrete. Since the exact value of diffusivity of aggregate is generally unknown, a model coarse aggregate was made of the mortar of known diffusivity and was used to make concrete samples. The measurement of the diffusivity on these samples showed that the diffusivity of concrete can be expressed in terms of the diffusivities and the volume fractions of the constituent materials. This result can be used to estimate an unknown diffusivity of aggregate, mortar or concrete when two of these three quantities are known.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 13001

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 11512

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 11484, 11722, 11830, 11831, 11832, 11833, 11835, 11837, 11838, 11840, 11846

12861 **Method for applying pyrolytic carbon coatings to small particles.** Beatty, R.L.; Kiplinger, D.V.; Chilcoat, B.R. (to Energy Research and Development Administration). US Patent 4,016,304. 5 Apr 1977. Filed date 17 Jun 1975. 4p.

PAT-APPL-587,004.

A method for coating small diameter, low density particles with pyrolytic carbon is provided by fluidizing a bed of particles wherein at least 50 percent of the particles have a density and diameter of at least two times the remainder of the particles and thereafter recovering the small diameter and coated particles. 3 claims.

12862 **Method for preparing metallated filament-wound structures.** Peterson, G.R. (to Energy Research and Development Administration). US Patent Application 751,623. 17 Dec 1976. 10p.

The fabrication of metallated filament-wound composites, and more particularly a method for preparing graphitized filament-wound composites in which metal carbides are incorporated in a unidirectional arrangement parallel with the wound filament is described.

STRUCTURE AND PHASE STUDIES

12863 **Deuteron and niobium-93 magnetic resonance study of niobium deuterides.** Barnes, R.G. (Technische Hochschule Darmstadt (Germany, F.R.). Fachbereich Physikalische Chemie und Chemische Technologie; Ames Lab., Iowa (USA); Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Physics); Roenker, K.P. (Thomas More Coll., Fort Mitchel, Ky. (USA)); Brooker, H.R. (University of South Florida, Tampa (USA). Dept. of Physics). *Ber. Bunsenges. Phys. Chem.;* **80**: No. 9, 875-881(Sep 1976).

Niobium deuterides in the composition range NbDsub(0,55)-NbDsub(0,88) were investigated by means of deuteron and ^{93}Nb magnetic resonance over the temperature range 4,2-420 K. The β-α transition, in the temperature range 340-415 K for these compounds, is sharply defined by the extinction of the deuteron quadrupole interaction as well as by the appearance of the central component of the ^{93}Nb spectrum when the cubic α phase is formed. These results are discussed in relation to other determinations of the β-α transition temperature. No other significant changes in the deuteron magnetic resonance spectrum are observed, down to 4.2 K, at which temperature the quadrupole coupling constants are essentially equal, with an average value, $e^2qQ/h = 33.0$ kHz. The temperature dependent behavior of the ^{93}Nb resonance spectrum indicates that the boundary between the $\alpha + \beta$ and β regions of the Nb-H(D) phase diagram must pass between the compositions NbDsub(0,78) and NbDsub(0,82) at 300 K. The NMR observations do not furnish positive support for the occurrence of the xi and epsilon phases nor for the occurrence of the cubic γ phase, but they are not incompatible with the occurrence of these phases.

PROPERTIES

REFER ALSO TO CITATION(S) 11481, 11482, 11795, 11880, 12672, 12860

12864 (Juel—1355) **Contribution to the subject 'fracture criteria for graphite'.** Cords, H.; Djaloeis, A.; Kleist, G.; Moench, J.; Oefinger, B.; Zimmermann, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Oct 1976. 52p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The interrelationship between fracture strengths determined by the uniaxial tensile test, the 3-point bend test, the compact tension (CT)-test and a modified CT-test specimen can be established with additional assumptions to Weibull's theory of fracture. These fracture tests were selected to demonstrate that in general the failure of graphite under mechanical loads may be estimated by the procedure presented in this report. However, further experimental investigations to determine the dependency of fracture strengths on volume should be performed in support of the above statement. Alternatively, it is recommended that the strength of graphite components to be subjected to irradiation should be determined using specially shaped test specimens. The test specimen should have the same stress distribution as that of the graphite component. This proposal is explained for the case of stresses in block-type nuclear fuel elements.

12865 **Entropy estimates of garnets and other silicates.** Saxena, S.K. (Brooklyn College, City Univ. of New York, NY). *Science;* **198**: No. 4313, 206-207(14 Oct 1977).

An example is given to illustrate the pitfall of estimating entropy from volume alone as was done earlier by Saxena with the garnets pyrope and almandine. A reply by Saxena is included. (GHT)

12866 **Experimental study on ultimate strength and strain behavior of concrete under biaxial compressive stresses.** Onuma, H.; Aoyagi, Y. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). *Denshi Gijutsu Sogo Kenkyusho Chosa Hokoku;* No. 375016, 1-4, 1-37(Jul 1976). (In Japanese).

The purpose of this investigation was to study the ultimate strength failure mode and deformation behavior of concrete under short-term biaxial compressive stresses, as an aid to design and analyze the concrete structures subjected to multiaxial compression such as prestressed or reinforced concrete vessel structures. The experimental work on biaxial compression was carried out on the specimens of three mix proportions and different ages with 10cm x 10cm x 10cm cubic shape in a room controlled at 20°C. The results are summarized as follows. (1) To minimize the surface friction between specimens and loading platens, the pads of teflon sheets

coated with silicone grease were used. The coefficient of friction was measured and was 3 percent on the average. (2) The test data showed that the strength of the concrete subjected to biaxial compression increased as compared to uniaxial compressive strength, and that the biaxial strength increase was mainly dependent on the ratio of principal stresses, and it was hardly affected by mix proportions and ages. (3) The maximum increase of strength, which occurred at the stress ratio of approximately $sigma^2/sigma^1 = 0.6$, was about 27 percent higher than the uniaxial strength of concrete. (4) The ultimate strength in case of biaxial compression could be approximated by the parabolic equation.

12867 Graphite—liquid—vapor triple point pressure and the density of liquid carbon. Haaland, D.M. (Sandia Labs., Albuquerque, NM). *Carbon;* **14**: 357-361(1976).

A detailed experimental investigation of the graphite—liquid—vapor triple point using a 400 W Nd;YAG continuous-wave laser as the heat source was completed and the triple point pressure accurately placed at 107 +- 2 atm (10.8 +- 0.2 MPa). Both X-ray diffraction and detailed microstructure of the recrysallized graphite were obtained to confirm melt. Careful experimental procedures were employed to address some of the remaining uncertainties in previous carbon triple point studies. These included accurate pressure measurements combined with apparatus designed to minimize pressure excursions. Also systematic melt experiments were completed in helium and argon as a function of sample size and laser power density to assure that sufficient power was available to produce melt at the triple point pressure and to prove, for the first time, that only carbon vapor was present at the sample surface during melting. Maximum mass loss rates were measured and used to confirm that non-equilibrium pressure excursions were experimentally insignificant. The presence of a bright laser-generated vapor or particle plume interfered with the temperature measurement and prevented the determination of the carbon triple point temperature. Finally, the density of liquid carbon near the triple point was calculated by quantitatively measuring the void fraction and density of the recrystallized melt. This density was found to be 1.37 +- 0.06 g/cm^3.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 13001

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 13073

12868 (HASL—300(Suppl.5)) **HASL procedures manual.** Harley, J.H. (ed.). (Energy Research and Development Administration, New York (USA). Health and Safety Lab.). Aug 1977. 102p. Dep. NTIS, PC A06/MF A01.

Additions and corrections to the following sections of the HASL Procedures Manual are provided: General, Sampling, Field Measurements; General Analytical Chemistry, Chemical Procedures, Data Section, and Specifications. (LK)

ACTIVATION AND NUCLEAR REACTION PROCEDURES

12869 (LBL—5961) **Samanid ceramics and neutron activation analysis.** Azarpay, G.; Frierman, J.D.; Asaro, F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 29 Aug 1977. Contract W-7405-ENG-48. 23p. (CONF-750355—4). Dep. NTIS, PC A02/MF A01.

From Conference on applications of physical sciences to medieval archaeology; Berkeley and Los Angeles, CA, USA (18 Mar 1975).

Glazed pottery known as "Afrasiyab" and "Nishapur" wares (early Islamic ceramics) are generally attributed to the Samanid dynasty (819-1005). The clay composition of Samanid wares and discarded kiln items found in situ were analyzed by NAA and the elemental composition compared with that of other sherds. 7 figures, 1 table. (DLC)

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 11470, 11647, 12878

12870 (LA—6978) **Determination of nitrogen in boron carbide with the Leco UO-14 Nitrogen Determinator.** Gardner, R.D.; Ashley, W.H.; Henicksman, A.L. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1977. Contract W-7405-ENG-36. 8p. Dep. NTIS, PC A02/MF A01.

Use of various metals as fluxes for releasing nitrogen from boron carbide in the Leco Nitrogen Determinator was investigated. Metals such as iron, chromium, and molybdenum that wet the graphite crucible all promoted nitrogen release. Tin, copper, aluminum, and platinum did not wet the graphite and were of no value as fluxes. A procedure for sample handling and the resulting performance of the method are described. The precision at 0.06 to 0.6 percent nitrogen averaged 4 percent relative standard deviation.

12871 Gas chromatographic analysis of gasolines containing olefins. Schulz, H. (Karlsruhe Univ. (TH) (Germany, F.R.). Engler-Bunte-Institut). *Erdoel Kohle, Erdgas, Petrochem. Brennst.-Chem.;* **30**: No. 4, 182(Apr 1977). (In German).

12872 Simple and rapid gas chromatographic method for the determination of dissolved deuterium and nitrogen in heavy water coolant of a nuclear reactor. Nair, B.K.S. (Rajasthan Atomic Power Station, Kota (India)). *Indian J. Technol.;* **14**: No. 10, 509-512(Oct 1976).

A known volume of a heavy water sample is equilibrated with a known volume of pure helium gas at atmospheric pressure in a sample tube. The dissolved gases evolve into the helium and distribute themselves between the gaseous and liquid phases according to their equilibrium partial pressures. These partial pressures of the gases in the equilibrium gas mixture are determined by analysing it gas-chromatographically. From these analytical data and the absorption coefficients of deuterium and nitrogen, their original concentrations in heavy water are calculated. Corrections for the increase in the total pressure of the gaseous phase owing to evolved gases are calculated and found to be negligible. Air contamination during sampling and analysis can be detected by the presence of the oxygen peak in the chromatogram and corrected for. The calculation is facilitated by programming it on an electronic calculator. The method is much simpler and faster than the vacuum method usually applied for this analysis. One determination can be completed in about an hour. The average deviation and standard deviation have been estimated at 0.19 ml/liter heavy water and 0.25 ml/liter heavy water respectively in deuterium, and 0.36 and 0.68 ml/liter in nitrogen.

12873 (ORNL-tr—4472) **Detecting 1,2-dichloroethane and carbon tetrachloride in water by liquid gas chromatography.** Keda, B.I.; Butyrin, V.A. Translated by G. Loard from *Gig. Sanit.;* No. 4, 64-66(1976). 4p. Dep. NTIS, PC A02/MF A01.

This work is devoted to quantitative analysis of dichloroethane, carbon tetrachloride and mixtures of them in water. In analyzing dichloroethane, carbon tetrachloride is used as an internal standard, while dichloroethane is used in the same capacity for analysis of carbon tetrachloride. Gas chromatography is used to evaluate the degree to which dichloroethane is removed from water in columns with activated carbon of various brands.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 11475

12874 Calibration of energy-dispersive x-ray spectrometers for analysis of thin environmental samples. Giauque, R.D.; Garrett, R.B.; Goda, L.Y. (Environmental Protection Agency, Research Triangle Park, NC). pp 153-164 of In X-ray fluorescence analysis of environmental samples. Dzubay, T.G. (ed.). Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977).

Four separate techniquess for calibrating energy dispersive X-ray spectrometers have been described. They include the use of (1) individual evaporated elemental thin-film standards, (2) nebulized multielement standard solution deposits to determine relative elemental sensitivity factors, (3) a semiempirical approach to calculate relative elemental sensitivity factors, and (4) thick pure element disks. The first three techniques are applicable for a broad range of elements. The utilization of nebulized multielement standard solution deposits, along with an evaporated single element thin-film standard for absolute system calibration, is the most accurate method of the calibration techniques described.

12875 Photon-induced x-ray fluorescence analysis using energy-dispersive detector and dichotomous sampler. Jaklevic, J.M.; Loo, B.W.; Goulding, F.S. (Univ. of California, Berkeley). pp 3-18 of In X-ray fluorescence analysis of environmental samples. Dzubay, T.G. (ed.). Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977).

An energy dispersive x-ray fluorescence system using photon excitation for elemental analysis of airborne samples is described. The system is designed for a large-scale aerosol sampling network. Experience with the system has shown that it is possible to perform automatic sampling and analysis of aerosol particles at a sensitivity and accuracy more than adequate for most air pollution studies. (BLM)

12876 Absorption corrections for submicron sulfur collected in filters. Loo, B.W. (Univ. of California, Berkeley); Gatti, R.C.; Liu, B.Y.H.; Kim, C.S.; Dzubay, T.G. pp 187-202 of In X-ray fluorescence analysis of environmental samples. Dzubay, T.G. (ed.). Ann Arbor, MI; Ann Arbor Science Publishers Inc. (1977).

A theoretical description of the mechanism that causes attenuation of x-rays in air particulate samples is presented. Experimental measurements of the attenuation factor for x-ray fluorescence analysis (XRF) of sulfur collected in cellulose ester membrane filters having 1.2-μm pore diameters are also presented. Direct x-ray attenuation measurements on K_2SO_4 and $CuSO_4 \cdot 5H_2O$ monodispersed aerosols collected on the filters showed that filter penetration was small and was not a strong function of particle size. The data indicated that a reasonable model for the particle deposition profile can be of the form of a surface component plus a component in the filter. The relative magnitude of the two components was expected to be a function of particle size, face velocity, loading, and the structure of the filter matrix; however, in the cases studied, the surface component was seen to largely dominate over the depth component. (BLM)

12877 Analysis of radioactive nuclides in reactor coolants. Rapid quantitative determination of nuclides by instrumental analysis. Masuda, O.; Shirakawa, N.; Shimizu, S.; Uramoto, Y.; Murota, K. (Kyushu Electric Power Co., Inc., Fukuoka (Japan)). *Kernenergie;* **45**: 145-158(Mar 1976). (In Japanese).

The improvement of accuracy, rapidness and labor-saving in the radioactive chemical analysis of the coolant of nuclear reactors was fundamentally examined, and the results of such improvement were applied to the radioactive chemical control of GENKAI No. 1 reactor. The nuclides of corrosion products were separated by the filtration of a suitable amount of coolant through a 0.45 micron Millipore filter. A cation filter collected the nuclides of corrosion products which passed through the Millipore filter and each filter was measured with the multiple pulse height analyzer of Ge(Li) gamma ray type. Thus the total amount of nuclides was determined. The anion nuclides of fission products were collected with a cation filter and the cation nuclides of the fission products were collected with an anion filter. Each filter was measured with the Ge(Li) gamma-ray multiple pulse height analyzer. In conclusion, the preparation of coolant sample can be performed rapidly and simply with the accuracy of measurement within 10%. The multiple pulse height analyzer provided with a minicomputer for analyzing gamma-ray spectra must be employed. The short half-life nuclides can be measured on a first day and the long half-life nuclides on a second day, thus the analysis of all nuclides can be carried out with the frequency of once per two days. Accordingly, the inspection of the soundness of nuclear fuel and the control of operation environment will become complete.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 12892

12878 Trace analysis of lead in oil by TLC. Turina, N.; Turina, S. (Zagreb Univ. (Yugoslavia)). *Chromatographia;* **10**: No. 2, 97-99(Feb 1977).

Trace amounts of lead contaminating a specimen of mineral oil were succesfully determined by TLC after concentrating the metal on microcrystalline cellulose, calcining and preparing final samples by take-up of the residues in small volumes of HCl. This method may also be applicable to other oils and to fats. Final determinations are made, after chromatographic separation of lead from other elements, by fluorimetric scanning of the chromatograms. Results are reliable with samples containing between 0.002 and 0.1 ppm of Pb, using a sample size of 25 cm^3. With Pb contents below 0.002 ppm, lead contamination of the chemicals used may cause difficulties, and the sample size must be increased. In contrast, when more than 0.1 ppm of Pb is expected, sample sizes should be reduced. sulfate ions interfere, and should be removed with $BaCl_2$ before chromatography.

12879 Atomic absorption spectrophotometric determination of arsenic and selenium in water by hydride generation. Corbin, D.R.; Barnard, W.M. (State Univ. of New York Coll., Fredonia, NY). *At. Absorpt. Newsl.;* **15**: No. 5, 116-120(1976).

As and Se are reduced and converted to their hydrides by an aqueous solution of sodium borohydride injected into an acidified sample contained in a reaction vessel by use of a syringe; the hydride is immediately transferred by nitrogen, without collection in a reservoir, to the atomizer of an atomic absorption spectrophotometer and burned in a hydrogen flame, and the absorption signal is recorded. The method may be used to analyze solutions containing as little as 0.01 μg/l As or Se. To determine total inorganic and organic forms, the organic compounds must be decomposed by an appropriate acid digestion prior to analysis; if the digestion is omitted, only inorganic As and Se are determined. The volatilization of the As and Se leaves behind many potentially interferring substances.

SEPARATION PROCEDURES

12880 Chromatographic monitoring procedures in laboratory practice. Kaplina, E.G.; Belova, O.I.; Lasunina, N.A. (Moscow Coke and Chemical Works). *Coke Chem., USSR (Engl. Transl.);* No. 4, 34-35(1976).

Translated from Koks Khim; No. 4, 27-29 (1976).

The Moscow Coke and Chemical Works consist of three plants in combination, viz., the coking plant, the synthetic ammonia plant using coke-oven-gas hydrogen and the oxygen plant. The plant requirements include daily analyses not only of the coke-oven gas but also of a rich gas and an ethylene fraction. The analyses are carried out in VTI-2 apparatus. The analytical data are used to calculate the calorific values and densities of the gases. The time requirements are very considerable and the laboratory has long been engaged in developing and introducing chromatographic procedures for the major constituents of coke-oven gas, rich gas and ethylene fraction. The procedure developed for the coke-oven and rich gases uses two parallel columns, one packed with molecular sieves and the other with grade KSM silica gel. Hydrogen was determined with argon as the carrier gas, and all other constituents with helium. The procedure was time-consuming and complicated. An attempt was made to separate the gases in an LKhM-7a chromatograph with a programme-controlled 50 to 250°C heating cycle, but the procedure still had a number of serious defects and could not be recommended for regular quality control. The final variant involved two parallel columns and a procedure based on that in GOST 14920 ("Dry gas. Proximate analysis"). The chromatograph was a type KhL-69 with a 6-way cock in the gas line so that each of the columns could be brought on stream in succession. The analytical column packings were zeolite (in a 2 m column) and diatomaceous brick with 25% n-hexadecane (in a 6 m column).

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 11477, 11811, 11812, 12061, 12904

12881 (IS-M—117) **New reduced zirconium halide phases from high temperature reactions.** Corbett, J.D.; Daake, R.L.; Cisar, A.; Guthrie, D.H. (Ames Lab., Iowa (USA)). 1977. Contract W-7405-ENG-82. 8p. (CONF-771060—2). Dep. NTIS, PC A02/MF A01.

From Electrochemical Society meeting; Atlanta, GA, USA (9 Oct 1977).

The number of reduced phases known in the Zr-ZrX_4 systems (X = F, Cl, Br, I) has recently been increased considerably by the results of high temperature equilibrations and transport reactions in sealed tantalum containers. Syntheses and properties are considered for the six new phases characterized structurally, namely, the double metal sheet structures of the metallic ZrCl and ZrBr, the single metal layers of $ZrCl_2$ (3R-NbS_2 type), and the first isolated zirconium clusters which occur in $(Zr_6Cl_{12})Cl_3$, Zr_6I_{12} and Zr_6Cl_{12}. The appreciable phase breadths which have been established for the $ZrCl_3$, $ZrBr_3$ and ZrI_3 phases are also presented together with x-ray powder diffraction evidence on the process.

12882 (LBL—6614) **Three-dimensional analysis of cellular microstructures by computer simulation.** Hanson, K.; Morris, J.W. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1977. Contract W-7405-ENG-48. 8p. (CONF-771109—19). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

For microstructures of the "cellular" type (isotropic growth from a distribution of nuclei which form simultaneously), it is possible to construct an efficient code which will completely analyze the microstructure in three dimensions. Such a computer code for creating and storing the connected graph was constructed. (DLC)

12883 (ORO—1797-77) **Lanthanide (III) and actinide (III) chelate kinetics via solvent extraction.** Choppin, G.R.; Muscatello, A.C.; D'Olieslager, W. (Florida State Univ., Tallahassee (USA). Dept. of Chemistry). 1977. Contract EY-76-S-05-1797. 6p. (CONF-771039—3). Dep. NTIS, PC A02/MF A01.

From 13. rare earth research conference; Olgebay Park, WV, USA (16 Oct 1977).

A method has been developed to study reactions whose half-lives are on the order of seconds to minutes for which fast-reaction relaxation techniques are not suitable and classical techniques are too slow. The technique of solvent extraction was adapted in a modified version of ligand exchange. A solvent extraction agent absorbed onto a hydrophobic solid support removes radioactive cations from an aqueous phase. The solid support prevents the formation of emulsions which form at the near neutral pH's used. Removal of filtered aliquots provides data on the rate of extraction which is a function of the decomposition rate of the complex, its formation rate,

and the extraction rate of the cation. The Eu(EDTA) chelate was studied.

12884 Raman spectra of supported molybdena catalysts. I. Oxide catalysts. Brown, F.R.; Makovsky, L.E.; Rhee, K.H. (Energy Research and Development Administration, Pittsburgh). *J. Catal.;* **50**: No. 1, 162-171(Oct 1977).

Raman spectroscopy has been used to study a variety of supported molybdena catalysts. In contrast to the infrared spectra of such catalysts, the Raman spectra are free of any significant contributions from the support materials, thus permitting observation of fundamental vibrations associated with the incorporated molybdenum components. Depending upon the amount of molybdenum incorporated into the support, the resulting Raman spectra are interpreted as indicating the presence of either bulk MoO_3 or interaction products of the molybdena species and the support or a combination of bulk MoO_3 and interaction species. In contrast to the spectra of the support materials alone, the Raman spectra of supported molybdenum oxide catalysts are generally free of any intense fluorescent background.

12885 Infrared study of NO and CO adsorption on a silica-supported Ru catalyst. Davydov, A.A.; Bell, A.T. (Univ. of California, Berkeley). *J. Catal.;* **49**: No. 3, 332-344(Sep 1977).

Infrared spectra were obtained for NO and CO adsorbed on reduced and oxidized Ru supported on silica. Adsorption of NO on a fully reduced sample produced bands at 1810 and 1860 cm^{-1}. With prolonged catalyst exposure to NO, the latter band shifted to higher frequencies. Spectra of NO adsorbed on an oxidized sample showed only a single band at 1880 cm^{-1}. Both the band at 1810 cm^{-1} and that occurring between 1860 and 1880 cm^{-1} are assigned to NO adsorbed as NO^+. The low frequency band is associated with adsorption on partially oxidized Ru sites and the high frequency band with adsorption on more fully oxidized sites. On a fully reduced sample, CO adsorption produced a single band at 2040 cm^{-1} which is assigned to linearly bonded CO. Oxidation of Ru and subsequent adsorption of CO produced bands at 2130 and 2070 cm^{-1}. This pair of bands is assigned to the symmetric and asymmetric stretches of two CO molecules bonded to a single oxidized Ru site.

12886 Infrared study of the reactions between NO and CO and NO and H_2 on a silica-supported Ru catalyst. Davydov, A.A.; Bell, A.T. (Univ. of California, Berkeley). *J. Catal.;* **49**: No. 3, 345-355(Sep 1977).

Observations of the interactions of NO with CO and H_2 on a silica-supported Ru catalyst have been performed using infrared spectroscopy. The formation of an isocyanate species was found when NO reacted with preadsorbed CO. When NO and CO interacted with the surface simultaneously, N_2O and CO_2 were formed in addition to the isocyanate species. Mechanisms for the formation of the isocyanate structure, N_2O, and CO_2 are proposed and discussed. Results of the interaction of NO with hydrogen (as D_2) showed that adsorbed NO reacted with D_2 to produce species containing N-D and O-D bonds.

12887 Effect of second sphere cations on formation of nickel (2) chloride complexes in molten salts. Volkov, S.V.; Buryak, N.I. (AN Ukrainskoj SSR, Kiev. Inst. Obshchej i Neorganicheskoj Khimii). *Zh. Neorg. Khim.;* **22**: No. 1, 150-154(Jan 1977). (In Russian).

The effect of the outer-sphere cations of alkali metals (A-Li^+, Na^+, K^+ + Rb^+ + or Cs^+) on complexing of Ni(2) in melts of ANO_3 and ACl has been studied. The effect of these cations on the equilibrium octahedral-tetrahedral nickel (2) complexes in melts of ANO_3 and ACl has been elucidated. It has been established that octahedral complex $[NiCL_6]^{4-}$ is formed with an outer-sphere cation Li^+, tetrahedral complex $[NiCl_4]^2$ with Rb^+ and Cs^+, and equilibrium $[NiCl_6]^{4-}$ reversible$[NiCl_4]^{2-}$ is observed in the case of Na^+ and K^+. The regularities in a change of spectroscopic parameters of the complex depending on an outer-sphere cation have been investigated.

12888 Potentiometric studies on stepwise biligand complex formation La(III), Pr(III) or Nd(III)-cyclo hexane-1, 2-diaminotetraacetic acid-hydroxy acid. Rana, H.S.; Tandon, J.P. (Rajasthan Univ., Jaipur (India). Chemical Labs.). *J. Inorg. Nucl. Chem.;* **39**: No. 8, 1391-1393(1977).

Potentiometric studies of the interaction between 1:1 Ln(III)-CDTA binary chelate (where Ln(III) = La(III), Pr(III) or Nd(III); CDTA = cyclohexane-1,2-diamino-N,N,N',N'-tetracetic acid) with certain hydroxy acids such as glycollic (GA), lactic (LA) and malic (MEA) are described. The nature of the titration curves indicates the stepwise addition of the secondary ligand to the initially formed 1:1, M(III)-CDTA binary complex. Formation constants (Ksub(MAL)) of the resulting biligand chelates have been determined at 30 +- 1° and 35 +- 1°C and also thermodynamic functions (viz. ΔG,ΔH and ΔS). The order of stability in terms of metal ions has been found to be La(III) < Pr(III) < Nd(III) and in terms of secondary ligand as MEA > LA > GA.

12889 Laminar flow mass transfer with axial diffusion in a tube with chemical reaction. Dang, V.D.; Steinberg, M. (Brookhaven National Lab., Upton, NY). *Chem. Eng. Sci.;* **32**: 326-328(1977).

Attempts to obtain a semi-analytical solution for the laminar flow mass transfer in a circular pipe with axial diffusion and chemical reactions are reported. The results of the mathematical solutions compare well with results of the finite difference method. The effect of axial diffusion was found to tend to retard the parabolic concentration distribution due to the field flow. (BLM)

12890 Superstructure and modulation wave analysis for the unidimensional conductor hepta- (tetrathiafulvalene) pentaiodide. Johnson, C.K.; Watson, C.R. Jr. (Oak Ridge National Lab., TN). *J. Chem. Phys.;* **64**: No. 6, 2271-2286(15 Mar 1976).

When acetonitrile solutions of tetrathiafulvalene [i.e., $(C_3S_2H_3)_2$; herein called TTF] and iodine, I_2, are allowed to mix by diffusion, monoclinic crystals are formed with the approximate composition $(TTF)_7I_5$. These crystals have an electrical conductivity along the needle axis c of 300 $ohm^{-1}cm^{-1}$ room temperature. A complete crystal structure analysis based on an approximate supercell with a = 48.016(16) A, b = 16.041(6) A, c = 24.877(7) A, β = 91.31(2)°, Z = 12 $(TTF)_7I_5$ was carried out using space group $P2_1/a$ with 225 nonhydrogen atoms in the asymmetric unit. The supercell space group $P2_1/a$ is the mathematical intersection of the two subcell space groups. The supercell is only approximate because 5 c_2 = 25.113(14) A which is about 1% longer than 7 c_1; consequently, the particular crystal studied has the formula $(TTF)\ I_{0.7076}$. The stacked TTF molecules are displaced from their ideal sublattice complex positions by displacement waves with rigid-body translational and rotational components. One- and three-dimensional Fourier analyses of the displacements show that TTF molecules are displaced predominantly by translational displacements along b and torsional rotations about c and that the periodicities are related to the iodine sublattice complex. Special techniques were developed for solving and refining dual-sublattice-complex crystal structures using a principle that interacting sublattice complexes Fourier transform as convoluting reciprocal lattices.

12891 Graphite-contained carbon, catalyst obtained therefrom and its use. MacCarroll, J.J.; Clark, J.T.K.; Tennison, S.R. (to British Petroleum Co., Ltd., London). German(FRG) Patent 2,538,346/A/. 11 Mar 1976. 19p. (In German).

The invention deals with a new form of graphite-contained carbon as catalyst carrier for platinum group metals. The carrier catalysts are effective for hydrogen transfer reactions. The specifications and production of the graphite-contained carbon are given. Ruthenium, rhodium, palladium, osmium, gold and preferably platinum and iridium are suitable as platinum group metals. The catalyst furthermore contains a small amount of alkali and/or alkali earth metal ions as modifying metal ions. The catalyst is prepared by impregnating the graphite-contained carbon carrier with a solution of a reducible platinum group metal compound and reducing the reducible compound to the metal. A few examples of dehydration and/or dehydrocyclization methods are given.

12892 Raman spectra of Al_2O_3 solutions in molten cryolite and other aluminum fluoride containing melts. Gilbert, B. (Univ. of Tennessee, Knoxville); Mamantov, G.; Begun, G.M. *Inorg. Nucl. Chem. Lett.;* **12**: 415-424(1976).

Experimental results are reported that show that oxide concentrations as low as 2 mole % can be detected in aluminum fluoride melts using Raman spectroscopy. Results of attempts to obtain further information on the complex species observed on dissolution of Al_2O_3 were not definitive, but species involving nonbridging Al—O bonds have been eliminated from consideration in concentrated Al_2O_3 solutions in aluminum fluoride containing melts. All new bands observed associated with the oxide were below 600 cm^{-1}. (BLM)

12893 Calculation of the electronic structure for the manganate and hypomanganate ions by the self consistent field Xα-scattered wave method. Jasinski, J.P. (Los Alamos Scientific Lab., NM); Holt, S.L. *J. Chem. Soc. (London), Faraday Trans., II;* **72**: 1304-1312(1976).

The electronic structures of the manganate and hypomanganate ions have been calculated by the self consistent field-X/sub α/-Scattered Wave Model. Ground state, charge density and transition state calculations have been made and compared with the electronic structure of the permanganate ion. Good agreement is observed between the calculated transition state energies and measured optical spectra of each of the ions of interest.

12894 Excitation temperature and electron number density distributions experienced by analyte species in an inductively coupled argon plasma. Kalnicky, D.J. Ames, IO; Iowa State Univ. (1976). 216p. University Microfilms Order No. 77-10,324.

Thesis (Ph. D.).

Spatially resolved, radial excitation temperatures and radial electron number density distributions experienced by analyte species in the observation zone of 15 to 25 mm above the load coil of a

toroidally shaped, inductively coupled argon plasma (ICP) are presented and related to the analytical performance of these plasmas. A comparison of radial temperatures measured with support gas (Ar I) lines and with a typical analyte thermometric species (Fe I) at 15 mm above the load coil is given. Radial (Fe I) excitation temperatures obtained at three observation heights (15, 20, and 25 mm) are compared for aerosol carrier gas flows of 1.0 l/min and 1.3 l/min. The addition of a large amount of an easily ionized element (6900 μg Na/ml) did not significantly change Fe I excitation temperature distributions at the respective aerosol carrier gas flows and observation heights. A comparison of radial electron number density distributions measured by the Saha-Eggert ionization and Stark broadening methods is given for an observation height of 15 mm above the load coil. The differences between the electron number density values obtained by these methods are discussed. The effect of addition of 6900 μg Na/ml on Saha-Eggert electron density distributions at these observation heights is also discussed. The computer programs employed in this investigation and discussions of the computational procedures incorporated in these programs are given in Appendices A - D.

12895 Reproducibilities of some physical properites of MgF_2. Bailey, D.M.; Calderwood, F.W.; Greiner, J.D.; Hunter, O. Jr.; Smith, J.F.; Schiltz, R.J. Jr. (Ames Lab., IA). *J. Am. Ceram. Soc.;* **58**: No. 11-12, 489-492(1975).

Optical-quality MgF_2 specimens selected to represent varying levels of fabrication stresses and impurities were examined to determine their elastic moduli, thermal expansions, and thermal conductivities. These properties proved to be insensitive to the variations in impurities among the samples. The elastic moduli were also insensitive to the variations in residual strain. Any sensitivity to residual strain was masked, in the case of thermal conductivity measurements, by the fracture of highly strained specimens during sample manipulation and, in case of thermal expansion measurements, by crushing the specimens to powder before measurement.

12896 Stable homopolyatomic anions: the crystal structures of salts of the anions pentaplumbide(2-) and enneastannide(4-). Corbett, J.D.; Edwards, P.A. (Iowa State Univ., Ames). *J. Chem. Soc., D;* 984-985(1975).

The unique trigonal bipyramidal Pb_5^{2-} and unicapped antiprismatic Sn_9^{4-} anions have been discovered by X-ray structural studies on their salts with Na^+ (2,2,2-crypt).

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 11713

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 11719

12897 Effect of dioxane content and resin cross linking on uranium isotope separation by inverse break-through processes. Ponta, A.; Calusaru, A. (Institutul de Fizica Atomica, Bucharest (Romania)). *Isotopenpraxis;* **13**: No. 6, 214-216(Jun 1977).

The effect of dioxane content and resin cross-linking on uranium isotope separation by chemical and ion exchange has been studied, using an inverse break-through experiment, where the tetravalent uranium is oxidized and eluted with ferric ion solution. The separation factors decrease in the presence of dioxane since the change of the chemical processes predominates over the increase of ion association due to the lower polarity of dioxane molecules. The low degree of cross-linking increases the equilibrium constants since the diffusion of the uranium species in the solid phase is faster, compared with the resin of higher cross-linking.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 11480, 11653, 12890

12898 Vapor-liquid equilibrium data of ethanethiol and tetrahydrothiopene in propane. Goetzinger, J.W.; Brinkman, D.W.; Poling, B.E.; Whisman, M.L. (Energy Research and Development Administration, Bartlesville, OK). *J. Chem. Eng. Data;* **22**: No. 4, 396-399(Oct 1977).

Equilibrium K values for the odorants ethanethiol, tetrahydrothiophene, and a mixture of the two in propane were determined at -23, 0, and 35°C. A technique was used in which samples from both the vapor and liquid phases were analyzed by gas chromatography, which gave K values to +-5%.

12899 Studies of molybdena-alumina catalysts. V. Relation between catalyst sulfided state and activity for thiophene hydrodesulfurization. Massoth, F.E. (Univ. of Utah, Salt Lake City); Kirby, C.L. *J. Catal.;* **47**: No. 3, 300-316(15 Jun 1977).

Sulfiding of a molybdena—alumina catalyst with thiophene/H_2 mixtures was studied by a gravimetric technique. Thiophene conversions were separately measured using a catalytic microreactor. Simultaneous measurements of catalyst changes and reactivity were also carried out in a stirred, microbalance reactor. Runs were made on oxidized, prereduced and presulfided catalysts. The results of sulfiding the catalyst with thiophene were similar to those previously obtained with H_2S. The predominant reaction was exchange of reactive O for S, with some anion vacancies also being formed. Prereduced catalysts sulfided to a lesser extent than the oxidized catalyst. Thiophene conversion varied with catalyst pretreatment and time on stream. A correlation between catalyst activity and catalyst surface concentrations is proposed based on dual sites consisting of anion vacancies and surface sulfide—oxide sites. It is supposed that the former are sites for thiophene adsorption and the latter for hydrogen adsorption and transfer.

12900 Manufacturing processes for propylene oxide and an electrochemical alternative. Simmrock, K.H. (Univ Dortmund, Ger). *Chem.-Ing.-Tech.;* **48**: No. 12, 1085-1096(Dec 1976). (In German with English abstract).

All the manufacturing processes for propylene oxide have considerable amounts of byproducts which provide a wastewater burden. After examination of existing processes the conclusion is reached that, within the existing production alternatives, an electrochemical process utilizing chlorine-resistant cation exchange membranes in alkali chloride electrolysis can greatly reduce the wastewater burden due to salts from the chlorohydrin process. 30 refs.

12901 Spin delocalization in the lowest triplet state of benzophenone. Mucha, J.A.; Pratt, D.W. (Univ. of Pittsburgh). *Chem. Phys. Lett.;* **37**: No. 1, 40-42(1 Jan 1976).

Ring atom hyperfine structure has been observed in the optically-detected magnetic resonance (ODMR) spectra of the lowest triplet states of 4,4'-difluoro- and 4,4'-dibromobenzophenone in a single crystal host at liquid helium temperatures. An analysis of this structure and its angular dependence yields a lower limit of 0.10 for the normalized π-orbital spin density in each of the para ring positions. These results, together with the demonstrated sensitivity of the zero-field splitting parameters to halogen substituents in the 4 and 4' positions, suggest that a significant amount of spin density resides on the phenyl rings in the $^3(n,\pi^*)$ state of benzophenone.

12902 Preliminary cost analyses for enzymatic hydrolysis of newsprint. Wilke, C.R.; Yang, R.D.; Stockar, U.V. (Univ. of California, Berkeley). *Biotechnol. Bioeng. Symp.;* No. 6, 155-175(1976).

A schematic flow diagram along with a discussion of the process is presented for an enzymatic hydrolysis process for newsprint. A cost estimate is made for the required capital investment and cost per pound of sugar produced in aqueous solution. The fixed capital cost is estimated as a multiple of purchased cost of the principal items of equipment. The total manufacturing cost is broken down into investment related costs, labor related costs, utilities costs, and raw material costs. The cost of cellulose from the process is in the current range for good-quality delignified wood pulp; however, it should be possible to produce a suitably delignified material at considerably lower cost if no consideration of fiber quality is necessary. (BLM)

12903 Mass spectra and ionization potentials of the neutral fragments produced during the electron bombardment of aromatic compounds. Reeher, J.R.; Flesch, G.D.; Svec, H.J. (Ames Lab., IA). *Org. Mass Spectrom.;* **11**: 154-166(1976).

A mass spectrometer equipped with a dual ionization chamber ion source has been used to characterize directly the neutral species produced in the dissociative ionization of gases by electron impact. Neutral fragment mass spectra have been obtained for the electron ionization and fragmentation of benzene, toluene, o-xylene, m-xylene, p-xylene, mesitylene and isotopically labeled toluene. The neutral fragment mass spectra correlate well with the structures of the molecules. The abundant species in the neutral fragment mass spectra also correlate reasonably well with the abundant complementary positive ions of the normal mass spectra. Ionization potentials have been determined for the abundant neutral species produced. Where comparisons with values reported elsewhere are possible, the agreement is usually within +-0.2 eV or less.

12904 Metal-porphyrin interactions. V. Kinetics of cyanide addition to a water soluble iron porphyrin dimer[1]. Hambright, P.; Rishnamurthy, M.K. (Howard Univ., Washington, DC). *J. Inorg. Nucl. Chem.;* **37**: 557-561(1975).

The kinetics of cyanide addition to the water-soluble oxy-bridged iron dimer of tetra (p-sulophenyl) porphin indicate that HCN is the reactant. The rate law is of the form: Rate = (3.8 +-0.2) x 10^4 (Fe dimer) (HCN)/(1 + (3.1 +- 0.3) x 10^{10} (H^+)) at 25° μ = 0.7 ($NaNO_3$). The cyano iron dimer dissociates into dicyano iron

monomers by two pathways, one first order in (H^+), and one proportional to $(H^+)(CN^-)^2$. The mechanism of this dimer reaction is compared to iron porphyrin monomer systems.

12905 Dynamic coordination chemistry of metalloporphyrins. Hambright, P. (Howard Univ., Washington, DC). pp 233-278 of In Porphyrins and metalloporphyrins. Smith, K.M. (ed.). Amsterdam; Elsevier Scientific Publishing Co. (1975).

Recent developments in the dynamic coordination chemistry of metalloporphyrins are reviewed. Various mechanisms of coordination are surveyed. 278 references are cited. (BLM)

ISOTOPE EFFECTS

12906 Crystal structure of D-glucaro-1,4-lactone monohydrate. Gress, M.E.; Jeffrey, G.A. (Brookhaven National Lab., Upton, NY). *Carbohydr. Res.;* **50**: 159-168(1976).

In the crystal structure of D-glucaro-1,4-lactone monohydrate, $C_6H_8O_7 \cdot H_2O$, the molecules have the E_3 lactone-ring conformation, with a small distortion of the ring to $_3T^2$. The α-hydroxycarboxylic acid side-chain is axial, with the HO—C—C=O torsion angle within 6° of cis-planar. The orientation of the side-chain is such that the hydroxyl group lies over the lactone ring, which is the same conformation as is reported to preponderate in solution. Calculations of non-bonding repulsion energy show that this conformation corresponds to an energy minimum, although comparable minima can also be obtained with the ring in the alternative ^3E conformation. The lactone and water molecules are hydrogen-bonded to form layers two molecules wide, separated by Van der Waals interactions. One of the water hydrogen atoms is involved in a weak, bifurcated hydrogen-bond.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

12907 2-methyl-3-butyn-2-ol as an acetylene precursor in the Mannich reaction. A new synthesis of suicide inactivators of monoamine oxidase. Fowler, J.S. (Brookhaven National Lab., Upton, NY). *J. Org. Chem.;* **42**: No. 15, 2637-2639(22 Jul 1977).

A two-step reaction process is reported for the synthesis of ^{11}C, ^{13}C, or ^{14}C-labelled propargylamines in moderate yields. The propargylamines were prepared by a modified Mannich scheme without the use of acetylene. The reaction scheme involved the use of 2-methyl-3-butyn-2-ol followed by KOH-catalyzed elimination of acetone from the acetylenic carbinols. (BLM)

ELECTROCHEMISTRY

12908 Carbon-electrodes and electrode operations in electrothermal processes. Zoellner, D.; Schieber, F. (Conradty (C.) Nuernberg G.m.b.H. und Co. K.G. (Germany, F.R.)). *Chem.-Ing.-Tech.;* **49**: No. 4, 335-337(Apr 1977). (In German).

From Lecture meeting on electrodes in electrochemistry; Erlangen, Germany, F.R. (7 - 8 Oct 1976).

Following a brief presentation of the systematics of electrothermal processes on electrodes in electrothermal chemical converters such as fusion electrolysis cells of high temperature fuel cells, as well as electrothermal converters such as direct resistance reaction furnaces, arc furnaces etc., a report is given particularly about the properties, quality and wear of carbon electrodes in industrial processes, especially fusion electrolysis.

12909 Reference electrodes. Lietzke, M.H. (Oak Ridge National Lab., TN). pp 317-324 of In High temperature high pressure electrochemistry in aqueous solutions, NACE-4. Houston, TX; National Association of Corrosion Engineers (1976).

From Conference on high temperature high pressure electrochemistry in aqueous solutions; Surrey, England (7 Jan 1973).

Representative work which has gone into the development and evaluation of a variety of reference electrodes for use at elevated temperatures is reviewed. A few of the many potential uses for these electrodes are indicated. Thirty-six references are cited. (BLM)

12910 Precision emf measurements on protolytic equilibria with the hydrogen electrode above 100 C. Mesmer, R.E.; Sweeton, F.H.; Hitch, B.F.; Baes, C.F. Jr. (Oak Ridge National Lab., TN). pp 365-374 of In High temperature high pressure electrochemistry in aqueous solutions, NACE-4. Houston, TX; National Association of Corrosion Engineers (1976).

From Conference on high temperature high pressure electrochemistry in aqueous solutions; Surrey, England (7 Jan 1973).

The results of the measurement of acidity in water solutions at high temperatures are reported. The studies were directed primarily toward systems related to nuclear reactor technology, i.e., coolant water of pressurized water reactors containing boric acid used as a soluble neutron poison and a strong base added to regulate the pH. Two different types of hydrogen electrode cells developed and employed on these solutions are (1) a stirred cell for titration-type experiments and (2) a flowing cell for measurements on systems with volatile components and particularly dilute solutions. Studies are reported on four different types of equilibria: (1) hydrolysis of metal ions, (2) self-ionization of the solvent, (3) dissociation or neutralization of weak acids, and (4) dissociation or neutralization of weak bases. Measurements are reported with a precision of about 0.01 log unit under ideal conditions, 0.02 log units up to 250°C, and about 0.04 log units at 300°C. (BLM)

PHOTOCHEMISTRY

12911 Effect of NO photolysis on NO/sub y/ mixing ratios. Duewer, W.H.; Wuebbles, D.J.; Chang, J.S. (Univ. of California, Livermore). *Nature (London);* **265**: No. 5594, 523-525(10 Feb 1977).

An investigation on the importance of the net NO/sub y/ sink resulting from the photolysis of nitric oxide and the subsequent reactions of nitrogen atom with nitric oxide in the upper stratosphere by means of a one-dimensional transport-kinetic model is reported. The effect of NO photolysis on NO/sub y/ mixing was studied using a parameterization of NO photolysis and chemical reactions. Inclusion of the sink was found to not result in a constant change in odd nitrogen mixing ratio above the height of a NO/sub x/ injection; however, the sink was found to have a significant effect on model predicted effects of chlorofluoromethanes. (BLM)

RADIATION CHEMISTRY

12912 Radiation effects on Fischer-Tropsch syntheses. Hatada, M.; Matsuda, K. (Japan Atomic Energy Research Inst., Neyagawa, Osaka. Osaka Lab. for Radiation Chemistry). *Radiobiologiya;* **10**: No. 3, 195-197(1977).

Radiation effects on Fischer-Tropsch synthesis has been examined using high dose rate electron beams and Fe-Cu-diatomaceous earth catalyst. Yields of saturated hydrocarbons were found to increase by irradiation, but the yields of these compounds were decreased by raising reaction temperature without irradiation, suggesting the presence of radiation chemical process in catalytic reactions.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

HOT-ATOM CHEMISTRY

REFER ALSO TO CITATION(S) 12907

PROPERTIES OF RADIOACTIVE MATERIALS

12913 (BNWL—2117, pp 505-530) **Field and laboratory observations on plutonium oxidation states.** Bondietti, E.A.; Reynolds, S.A. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

Test methods for evaluating Pu oxidation state species in experimental samples were developed and tested. These methods, which are based on solvent extraction and coprecipitation principles, enabled the elucidation of Pu(VI) and Pu(IV) monomeric species in laboratory soil-water equilibration studies, plutonium dioxide dissolution studies, and in seepage solution collected near a solid waste burial ground. The methods employed also allowed the identification of soluble polymeric Pu species which do not revert to monomeric forms upon acidification.

12914 (INIS-mf—3579) **Transuranium.** Agbert, W.Z. (Atomic Energy Organization of Iran, Teheran. Centre for Research and for Application of Radioisotopes). Oct 1976. 15p. (In Iranian). Dep. NTIS (US Sales Only), PC Aπ2/MF A01.

From Transuranium; Teheran, Iran (18 Oct 1976).

How transuranium elements came into existence, and thein and synthesis are briefly dealt with. The applicability of ^{239}Pu in reactors as nuclear fuel, ^{238}Pu in nuclear medicine and as a heat source, and ^{252}Cf and ^{241}Am as neutron sources are discussed, utility of ^{241}Am for preparing pure ^{238}Pu is considered. Physico-technical problems on synthesizing transuranium elements and thein production in nuclear power plants are presented. Ultimately, disposal of radioactive materials in salt mines and its safety aspects are discussed.

12915 Charge and nature of technetium species produced in the reduction of pertechnetate by stannous ion. Owunwanne, A.; Mar-

insky, J.; Blau, M. (State Univ. of New York, Buffalo). *J. Nucl. Med.;* **18**: No. 11, 1099-1105(Nov 1977).

By using a cation-exchange distribution technique, the net charge of the technetium species produced in the reduction of pertechnetate by stannous ion at ph equal to or less than 2 has been determined to be +2. The species carrying this charge is either the dihydroxy technetate ($Tc(OH)_2^{2+}$) ion or the oxotechnetate (TcO^{2+}) ion. These species are hydrolysed to technetium dioxide dihydrate ($TcO_2 \cdot 2H_2O$) at higher pH. The advantage of the ion-exchange distribution technique for these studies is that they can be done with carrier-free technetium rather than at the high concentrations required for the more conventional methods of ion-charge determination. The results, therefore, are more likely to be applicable to the situation existing in the routine preparation of Tc-99m radiopharmaceuticals.

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 11806

12916 Single nonisothermal noncatalytic solid-gas reaction. Rehmat, A.; Saxena, S.C. (Univ. of Illinois, Chicago). *Ind. Eng. Chem., Process Des. Dev.;* **15**: No. 2, 343-350(Apr 1976).

The effect of changing particle size and other time-dependent phenomena, including intermolecular gas film diffusion, intraparticle ash layer diffusion, and chemical reaction rate, on conversion-time relationships in a spherical pellet undergoing a first-order irreversible reaction was deduced from a shrinking-core model. For both isothermal and nonisothermal conditions, particle size changes proved significant whenever the reaction was controlled by intermolecular and/or intraparticle diffusion. When both intermolecular and intraparticle resistances were present simultaneously and the heat transfer coefficient was small, the shrinking particle required less time than the growing particle to give a particular conversion in the nonisothermal case but more time in the isothermal case. The results of this U.S. Energy Research and Development Administration-supported study, which could apply also to coked catalyst regeneration, will be used to model fluidized bed reactors for coal conversion.

ENGINEERING

REFER ALSO TO CITATION(S) 11504

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 11442, 12814, 12815, 12818, 13021

12917 (ORNL/MIT—254) **Parameters influencing dispersion in a three-phase fluidized bed.** Cherry, R.S.; Sharon, A.C.; Chen, Z.P. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 19 May 1977. Contract W-7405-ENG-26. 46p. Dep. NTIS, PC A03/MF A01.

The effects of liquid and gas superficial velocity, solids loading, and particle diameter on axial dispersion in a three-phase fluidized bed were investigated. Gas velocities of 4 to 16 cm/sec and liquid velocities of 4 to 12 cm/sec through the 7.62-cm-ID bed were utilized with 1.5, 2.25, and 3.0 kg loadings of 0.32 and 0.46-cm-diam glass beads. Larger beads (0.62-cm-diam) were fluidized with the same range of gas velocities but at liquid velocities of 5 to 12 cm/sec and at a 1.5-kg loading. Dispersion coefficients were calculated by analyzing the spread of an injected tracer with three methods: an analysis of moments, a modified analysis of moments, and a transfer function. There is excellent agreement among the three methods when applied to symmetrical, idealized data. However, the agreement is very poor when the methods are applied to experimental data. Several modifications in the column design and tracer monitoring apparatus are suggested.

12918 (SAND—77-1126) **One-dimensional approximate technique for earth penetration calculations.** Yarrington, P. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1977. Contract EY-76-C-04-0789. 45p. Dep. NTIS, PC A03/MF A01.

The penetration process is approximated by the one-dimensional expansion of a cylindrical cavity in an infinite solid. Linear and quadratic forms are used to describe, piecewise, the volumetric response of the target during loading at the shock front. It is assumed that the density locks at the shocked state. The shear strength of the target is taken to be a piecewise linear function of pressure. However, it is assumed that the target material is weak in shear and, thus, that the effect of shear strength can be treated as a perturbation on the hydrodynamic solution. For conical-nosed penetrators an analytic expression for the normal stress results from the analysis, while for ogival-nosed penetrators the solution must be obtained numerically. A computer program, PENAP, was written to treat both the ogive and cone geometry, and PENAP solutions were found to agree well with both experimental data and TOODY, two-dimensional finite-difference wavecode results. It should also be noted that the PENAP calculations typically required several orders of magnitude less computer time than did the TOODY calculations.

12919 (UCRL—80302) **Computationally directed aspheric figuring.** Brown, N.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Nov 1977. Contract W-7405-ENG-48. 24p. (CONF-771138—4). Dep. NTIS, PC A02/MF A01.

From Optical Society of America workshop on optical fabrication and testing; San Mateo, CA, USA (10 Nov 1977).

A simplified version of wear theory applicable to a wide variety of axisymmetric aspherics is developed. Several programs consistent with programmable hand calculators are presented and a problem is worked in detail.

12920 Dynamics of heat exchanger tube banks. Chen, S.S. (Argonne National Lab., IL). *J. Fluids Eng.;* **99**: No. 3, 462-469(Sep 1977).

Flow-induced vibration in heat exchanger tube banks is of great concern, particularly in high performance heat exchangers used in nuclear reactor systems. The dynamic characteristics of tube banks in stationary liquid are studied. A method of analysis is presented for free and forced vibrations of tube banks including tube/fluid interaction. Numerical results are given for tube banks subjected to various types of excitations.

12921 Finite element static analysis of axisymmetric solids with material and geometric nonlinearities. Hartzman, M. (US Nucl Regul Comm, Washington, DC). *J. Pressure Vessel Technol.;* **99**: No. 3, 386-393(Aug 1977).

Paper No. 76-PVP-A.

12922 Method of sealing. Groh, E.F.; Cassidy, D.A. (to Department of Energy). US Patent Application 763,167. 27 Jan 1977. 6p.

A method of sealing a thermocouple lead or other small diameter wire, cable or tube in a thin wall is described. A thermocouple lead, etc., is passed through a thin material such as sheet metal and sealed by shear-drawing complementary longitudinally angled, laterally rounded grooves having coplanar deep ends in both sides of the thin material with shearing occurring at the deep end faces to form a rounded opening in the thin material substantially perpendicular to the plane of the thin material, passing a thermocouple lead or similar object through the opening so formed and sealing the opening with a sealant which simultaneously bonds the lead to the thin material.

12923 Variable orifice using an iris shutter. Beeman, R.; Brajkovich, S.J. (to Energy Research and Development Administration). US Patent Application 760,305. 18 Jan 1977. 17p.

A description is given of a mechanism capable of providing control of material, gas, or fluid flow, and more particularly to a variable orifice forming mechanism utilizing an iris shutter arrangement. A variable orifice forming mechanism utilizing an iris shutter arrangement adapted to control gas flow, conductance in vacuum systems, as a heat shield for furnace windows, as a beam shutter in sputtering operations, and in any other application requiring periodic or continuously-variable control of material, gas, or fluid flow.

12924 Edge effect in d.c. mhd pumps with double channel. Stanciu, D. (POlytech Inst of Bucharest, Rom). *Rev. Roum. Sci. Tech., Ser. Electrotech. Energ.;* **22**: No. 2, 181-191(1977).

The phenomena which occur in the fluid mass, in the input and output zones of the dc magnetohydrodynamic (MHD) pumps, are studied. There is evidenced the dependence of the intensity of these phenomena on the active zone geometrical configuration, on the rate of the fluid flow through the channel and on the law of the magnetic field space variation in the edge zones of the pump.

12925 Graphite fiber reinforced structure for supporting machine tools. Knight, C.E. Jr.; Kovach, L.; Hurst, J.S. (to Energy Research and Development Administration). US Patent Application 751,622. 17 Dec 1976. 10p.

Machine tools utilized in precision machine operations require tool support structures which exhibit minimal deflection, thermal expansion and vibration characteristics. The tool support structure described is a graphite fiber reinforced composite in which layers of the graphite fibers or yarn are disposed in a $0/90^0$ pattern and bonded together with an epoxy resin. The finished composite possesses a low coefficient of thermal expansion and a substantially greater elastic modulus, stiffness-to-weight ratio, and damping factor than a conventional steel tool support utilized in similar machining operations.

12926 Omega-x micromachining system. Miller, D.M. (to Energy Research and Development Administration). US Patent Application 750,317. 14 Dec 1976. 70p.

A micromachining tool system with X- and omega-axes is used to machine spherical, aspherical, and irregular surfaces with a maximum contour error of 100 nanometers (nm) and surface waviness of no more than 0.8 nm RMS. The omega axis, named for the angular measurement of the rotation of an eccentric mechanism supporting one end of a tool bar, enables the pulse increments of the tool toward the workpiece to be as little as 0 to 4.4 nm. A dedicated computer coordinates motion in the two axes to produce the workpiece contour. Inertia is reduced by reducing the mass pulsed toward the workpiece to about one-fifth of its former value. The tool system includes calibration instruments to calibrate the micromachining tool system. Backlash is reduced and flexing decreased by using a rotary table and servomotor to pulse the tool in the omega-axis instead of a ball screw mechanism. A thermally-stabilized spindle rotates the workpiece and is driven by a motor not mounted on the micromachining tool base through a torque-smoothing pulley and vibrationless rotary coupling. Abbe offset errors are almost eliminated by tool setting and calibration at spindle center height. Tool contour and workpiece contour are gaged on the machine; this enables the source of machining errors to be determined more readily, because the workpiece is gaged before its shape can be changed by removal from the machine.

12927 Nose tip locking device. Andersen, J.A.; Harty, G.R. (to Energy Research and Development Administration). US Patent Application 744,472. 24 Nov 1976. 8p.

Nose tip securing devices are described for releasably locking a nose tip onto a space reentry vehicle so that even if the nose tip is radioactive, it may be safely attached and detached from the vehicle. A mechanism is provided for locking and releasing a nose tip to a vehicle comprising a shaft having first and second ends, the first end of the shaft comprising a ratchet and the second end of the shaft comprising a pinion. The ratchet engages a pawl which allows the former's rotation in only one direction unless the pawl and ratchet are separated. A locking device is operably connected to the pinion. One object of the present invention is to improve personnel safety while attaching and detaching radioactive nose tips from vehicles. Another object of the invention is to provide easy interchangeability of nose tips for a vehicle. One advantage of the present invention is that radioactive nose tips can be attached to and detached from vehicles with minimal exposure to personnel. Another advantage of the present invention is that electrical connectors can be blind-mated.

12928 Cryogenic expansion machine. Pallaver, C.B.; Morgan, M.W. (to Energy Research and Development Administration). US Patent Application 740,330. 9 Nov 1976. 9p.

A reciprocating expansion-engine refrigerator for cooling helium to a low temperature is described. The cryogenic expansion engine includes intake and exhaust poppet valves each controlled by a cam having adjustable dwell, the valve seats for the valves being threaded inserts in the valve block. Each cam includes a cam base and a ring-shaped cam insert disposed at an exterior corner of the cam base, the cam base and cam insert being generally circular but including an enlarged cam dwell, the circumferential configuration of the cam base and cam dwell being identical, the cam insert being rotatable with respect to the cam base.

12929 Examination of interior surfaces using glow-discharge illumination. Lord, D.E.; Peteini, R.R.; Carter, G.W. (to Energy Research and Development Administration). US Patent Application 740,338. 9 Nov 1976. 9p.

A method is described for endoscopic examination of the interior of a hollow structure through a light pipe that is inserted into the structure. The interior is illuminated by means of a glow discharge that is established with a high voltage applied between the structure wall as one electrode and a second electrode that is inserted into the structure, or establishing the glow with two electrodes inserted into the structure.

12930 Spin ejector. Andersen, J.A.; Flanigan, J.J.; Kindley, R.J. (to Energy Research and Development Administration). US Patent Application 737,649. 2 Nov 1976. 8p.

Spin ejectors and, more particularly, spin ejectors for reentry and orbital vehicles are described. An apparatus for spin launching or ejecting a body comprises a base plate, a main ejection shaft extending perpendicularly from the base plate, a compressible spring disposed about the shaft, a bearing between the shaft and the spring, and a housing containing a helical slit releasably engaged with the base plate surrounding the shaft, bearing and spring. A piston guided by the shaft and the bearing is seated on the spring. The piston comprises an aperture follower fitted into and guided by the housing aperture. The spring is compressed prior to launch and when released causes the piston to spin launch a vehicle. One object of the present invention is to provide spin ejection, essentially free of tip-off error, for a reentry vehicle from a launch body. Another object of the instant invention is to provide, for a plurality of vehicles, substantially errorless independent launch trajectories from a launch body.

12931 Transitional processes in a cylindrical induction pump fed from a separate synchronous generator. Gekht, G.M.; Tolmach, I.M. *Magnetohydrodynamics (USSR) (Engl. Transl.);* **12**: No. 1, 99-104(1976).

The article discusses the transitional process in an electromagnetic three-phase induction pump, fed from a separate synchronous generator, with vanishing of the grid voltage to a rotating generator of the electric motor. A simultaneous numerical solution is given to the equations of the primary circuit of the windings of the pump, the equations of the electrical currents in the liquid metal, the equations of the motion of the liquid metal, as well as the equations of the feeding synchronous generator. The results of a numerical calculation of transition conditions for a pump with a feed of 20,000 m$sup 3$/h are given. 3 refs.

12932 Pressure losses due to circulation currents in the shaped channel of an mhd pump with axial current. Gel'fgat, Yu.M.; Gorbunov, L.A. *Magnetohydrodynamics (USSR) (Engl. Transl.);* **12**: No. 1, 116-119(1976).

The paper considers the mechanism for additional pressure loss Δp/sub c/ in the channel of a pump with axial current supply, resulting from interaction of the transit flux with circulation fluxes in the streams at the channel wall. It is shown that the interaction of the transit and circulation fluxes is purely hydraulic in nature. A number of experimental results is presented for Δp/sub c/ as a function of the parameter $p_0 = IB/d$ and the channel geometry.

12933 Vibrations of a row of circular cylinders in a liquid. Chen, S. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 75-DET-22, 1-7(1975).

The effects of interaction with surrounding liquid on the dynamic behavior of a row of circular cylinders are studied analytically. First the hydrodynamic forces associated with cylinder motions are obtained using the potential flow theory. Then a method of solution is presented for free and forced vibrations of a row of cylinders. The results of this study have important application in the modeling of crossflow-induced vibration of heat-exchanger tubes. 12 refs.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 12965, 13010, 13014, 13018, 13274, 13500, 13501

12934 (LBL—6718) Quenches in large superconducting magnets. Eberhard, P.H.; Alston-Garnjost, M.; Green, M.A.; Lecomte, P.; Smits, R.G.; Taylor, J.D.; Vuillemin, V. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 10p. (CONF-770842—14). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The development of large high current density superconducting magnets requires an understanding of the quench process by which the magnet goes normal. A theory which describes the quench process in large superconducting magnets is presented and compared with experimental measurements. The use of a quench theory to improve the design of large high current density superconducting magnets is discussed.

12935 Calculation of asymmetric reaction forces of coaxial cylindrical magnet coils. Auinger, H. (Siemens, Nuernberg, Ger). *Siemens Forsch.- Entwicklungsber.;* **6**: No. 1, 13-21(1977). (In German).

Coaxial cylindrical magnet coils produce reaction forces on eccentric and axial displacement, or torques on canting of the axis. Simple formulas for determining these are derived and discussed for a 30 T-hybrid magnet design. For simplification, the exponential series for describing the magnetic field (excited from the outer coil) are terminated after the 4th order terms. Eccentric circles, exact analytical treatment of which would lead to elliptic integrals, are, however, replaced by Pascal's limacons. Since, in practice, the asymmetric coil displacements are relatively small, the error resulting from this simplification is no greater than the computational error.

12936 Cryogenic cable with a number of conducting leads. Matthaeus, G.; Koehler, H.; Massek, P. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,250,657/B/. 2 Dec 1976. 5p. (In German).

A cryogenic cable for three-phase ac current transmission is described. The cable is provided with an external tube in which a system of 3 internal tubes is arranged. Each internal tube contains a conductive lead cooled down to low temperature by means of a coolant. The conductive lead has a tube-shaped inner conductor and an external conductor coaxial to it. According to the invention, the

diameter of one of the internal tubes is bigger than the diameter of the other two internal tubes and the flow direction of the coolant for cooling the external and internal conductors of each conductive lead is in the internal tube with the bigger diameter opposite to that of the coolant in the other two internal tubes.

12937 Method to produce a conductor made of superconducting material. Scheffler, E.; Ziemek, G. (to Kabel- und Metallwerke Gutehoffnungshuette A.G., Hannover (Germany, F.R.)). German(FRG) Patent 1,912,491/B/. 18 Nov 1976. 3p. (In German).

The invention deals with a method to produce an electrical conductor made of superconducting layers which is to be used, e.g., in ultracold cables, with a layer of a superconducting alloy or compound of at least two components, one or more of which have been diffused in by heat treatment. According to the invention, a carrier, e.g. a copper wire with a tin layer, is wound off a supply drum and is coated with a thin-walled band of the second higher-melting component, e.g. niobium. This band is formed into a tube whose edges are welded together, which is then drawn down to the tin layer of the wire by means of a clamping jam and a drawing matrix arranged behind the welding unit. The conductor is then heat-treated in an annealing furnace under inert gas or in a vacuum at 950 to 1,200°C, so that a hard superconducting layer is produced by letting niobium and tin diffuse into each other. The conductor leaving the annealing furnace is then wound on a supply drum.

12938 Process for the production of a superconductor with an intermetallic compound consisting of at least two elements. Ziegler, G.; Frohmader, S.; Wilhelm, M. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,423,882/C/. 4 Nov 1976. 13p. (In German).

The invention deals with a method to produce a superconductor with a superconducting intermetallic compound of at least two elements. According to the invention, the second or the other components of the superconducting intermetallic compound are introduced by a chemical transport reaction. To produce a Nb_3Sn multicore conductor, for example, a niobium rod is put into a copper tube and drawn into a long wire. 19 pieces of this wire are made into a bundle, put into a copper tube, and cold-drawn until the niobium cores have been reduced to 20 μm diameter and the copper matrix to 200 μm diameter. This wire is wound around a ceramic tube and placed inside a quartz ampoule together with a certain amount of tin. After filling, it is melted off with HCl gas and heated to 750°C for 16 hours. During this process, the copper matrix is converted into copper-tin and Nb_3Sn layers 1 to 2 μm thick are formed on the surface of the niobium cores.

12939 Method to produce a conductor tube, in particular for superconducting cables. Diepers, H.; Muesebeck, H. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 2,311,875/C/. 28 Oct 1976. 12p. (In German).

A method to produce a conductor tube which consists of a niobium and a copper layer and is used especially for superconducting cables is described. With vertical tube axis, an electrolyte copper layer held by a supporting tube, is vacuum-deposited on the inner or outer surface of the niobium tube. With a residual gas pressure of 10^{-4} torr at the highest, the copper is deposited, by means of a high-frequency heating coil, only in a small zone which is moved from the lower to the upper end of the pipe. The resulting piece of tube, which consists of a niobium and a copper layer, is then cold-drawn in several steps to form a longer tube of reduced outer diameter and wall thickness with the help of drawing aids.

12940 Temperature measuring device on a heat-insulated container for the storage of low-boiling liquefied gases. Katsuta, Kihei; Watanabe, Nobuya; Matsuyama, Chiaki. (to Mitsubishi Jukogyo K.K., Tokyo (Japan)). German(FRG) Patent 2,409,613/B/. 28 Oct 1976. 2p. (In German).

The invention deals with a leak-indicating device on a heat-insulated storage container for low-boiling liquefied gases. The container has a rigid outer wall with a plastic-foam heat insulation on its inner side. On the inner side of the plastic-foam insulation, there is a liquid-proof layer. The heat insulation consists of two layers. Between these two layers, there is a third, liquid-proof and electrically insulating layer with temperature sensors. The temperature sensors consist of conductors arranged cross-wise in mesh form, and of magnetic cores whose material becomes unmagnetic below a certain temperature, connected with the conductors at the crossing points. In case of a leak, cold liquid will come close to the nearest magnetic core and demagnetize it. The electrical change thus caused is indicated by an indicator which also gives information on the location of the leak.

12941 Method and installation for the production of heat energy at low temperatures. Prost, R.; Broche, J. (to L'Air Liquide, 75 - Paris (France)). German(FRG) Patent 2,557,093/A/. 8 Jul 1976. 23p. (In German).

The invention concerns a refrigeration source, whose temperature ajusts itself to a pre-set and definite value. The equipment includes two regenerators, whose refrigeration ends are connected to each other by a canal, which has a calibrated reduced section. The refrigeration ends and their connection are inserted into a copper block, which acts as the refrigeration source. The heating end of the lst regenerator is joined to the suction side of a compressor over a switchable valve, while the front side of the compressor is joined to the heating end of the 2nd regenerator over a exchanger and again a switchable valve; when the valve is switched the regenerators are joined to the circuit in an opposite way. The other side of the heat exchanger is, for example, flowed through by tap water for the purpose of cooling. The circuit described is charged with a gas mixture, which consists of hydrocarbon with different boiling points, and, when necessary, consisting of a nitrogen portion. Thus, the gas charge is led from the regenerator, under pressure, into the second one, where condenses by graduation from heat end to refriguration end. The valves are switched back as soon as the initial pressure of the gas has reached a reference value. For this purpose a pressure measuring sensor is provided, which activates a control device, i.e. an electronic control device, which is the main item of this invention.

12942 Stabilized A.C. superconductor. Massar, E.; Parsch, C.P. (to Siemens A.G., Berlin (Germany, F.R.); Siemens A.G., Muenchen (Germany, F.R.)). German(FRG) Patent 1,765,109/C/. 2 Oct 1975. 5p. (In German).

The device described is a three-phase-current-superconductor in which the superconducting layer of type I or II with negligibly low resistance which is originally intended for the load current is placed on a metallic stabilization layer taking the current at least partially in case of over-load. This stabilization layer is made of superconducting material of type III and is formed as a tube; it is surrounded by the concentric tube of the superconducting layer of type I or II touching it. The thickness of the two superconducting layers is 1-10 μ. In the inner part there is a core of material conducting normally at low temperatures, e.g. copper or aluminum. The whole conductor is flown through or surrounded by a coolant on its inner and/or outer side.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 11435, 11756

12943 (UCRL—50016-77-2, pp 13-20) **PARET: applications to structures.** Smith, P.D. 30 Jun 1977.

In Mechanical Engineering Department quarterly report, April—June 1977.

System identification techniques, which estimate and thus identify the parameters describing some real system, can be used in structural analysis to improve mathematical models. The LLL-developed Parameter Estimation Technique (PARET) offers improvements over classical techniques and has been applied to the response of structures during earthquakes and identified structural parameters such as natural frequency and damping. These compare very well with the parameters produced by the structural analysis computer program, SAPIV, and with actual data. In the future, techniques like PARET will probably occupy a much more prominent role in the design and qualification of critical facilities such as nuclear power plants for extreme loads.

SHIPPING CONTAINERS

12944 (SAND—77-0971C) **Radiation shield design for LMFBR spent-fuel shipping casks.** Dupree, S.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 8p. (CONF-771109—68). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

Previous analyses have examined a limited number of the alternatives available for designing an LMFBR spent-fuel shipping cask (SFSC) using a non-volatile neutron shield; i.e., a neutron shield which will not be lost in an accident involving a fire. The present study extends the scope of these hypothetical designs to include combinations of volatile and non-volatile neutron shield materials.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 12987

LASERS

12945 (LA-UR—77-2529) **Use of non-quarter-wave designs to increase the damage resistance of reflectors at 532 and 1064 nanometers.** Gill, D.H.; Newnam, B.E.; McLeod, J. (Los Alamos Scien-

tific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-771061—1). Dep. NTIS, PC A02/MF A01.

From Symposium on optical materials for high power lasers; Boulder, CO, USA (4 Oct 1977).

The damage resistance of multilayer dielectric laser reflectors has been increased by using non-quarter-wave thicknesses for the top few layers. These designs minimize the standing-wave electric field in the high-index layers, which are generally the weaker layers. Algebraic equations have been derived for optimum film thicknesses and for the resulting peak electric fields. Five sets of reflectors for 532 and 1064 nm were fabricated according to these designs by two vendors using two different material combinations. Each set contained one reflector of standard all-quarter-wave design and three reflectors each with a different number of modified layers. The damage thresholds of the modified designs were found to be higher than the all-quarter-wave designs, in some cases by a factor greater than 2. The damage thresholds have been analyzed and explained in terms of standing-wave electric field patterns.

12946 1MW p-terphenyl dye laser. Buecher, H.; Chow, W. (Max-Planck-Institut fuer Biophysikalische Chemie (Karl-Friedrich-Bonhoeffer-Institut), Goettingen (Germany, F.R.). Abt. Laserphysik). *Appl. Phys.;* **13**: No. 3, 267-269(Jan 1977).

P-terphenyl in cyclohexane has been pumped by a KrF laser in a longitudinal configuration. Dye laser pulses of 11 mJ, 1 MW were obtained with over 10% conversion efficiency. N_2 purge of the dye solution is shown to increase the conversion efficiency. The tuning curve between 321.8 nm and 365.3 nm is presented.

12947 Optimum cross-section for discharge of a constant current in a laser based on Ar II ions. Alferov, G.N.; Donin, V.I.; Yurshin, B.Ya. *Zh. Prikl. Spektrosk.:* **25**: No. 1, 40-42(Jul 1976). (In Russian).

Experiments are described on optimizing the discharge cross-section of a continuous laser based on Ar II ions. Experiments were carried out with slit and cylindrical discharge tubes in a region of currents saturating the light generation. It is noted that discharge instabilities in the region of saturating currents are concomitant in character, and can be removed by applying a weak, constant magnetic field in the near-electrode regions of discharge. The experiments show that discharge tubes with a diameter <20 mm are optimal for the output characteristics for a continuous, argon-ion laser with single-pass excitation. (SJR)

12948 High-frequency automodulation of radiation from quantum generators with an inertial feedback. Milinkevich, A.V.; Savva, V.A.; Samson, A.M. *Zh. Prikl. Spektrosk.;* **25**: No. 1, 43-51(Jul 1976). (In Russian).

Laser feedback inertia exists because of the finite passage time of the radiation along the resonator. In particular inertia manifests itself when laser losses or amplification are noticeably changed after a passage of time T. In these cases a single pulse modulated with a "period" T appears at the exit. A detailed description is given how an inhomogeneity occurs in the distribution of radiation density, and how it is converted to a traveling pulse between the mirrors and causes modulation of the exit radiation. In a standing wave laser in contrast to a single-directional ring laser, not one but two pulses per passage can be formed. Their relative amplitudes and durations depend on the parameters and positions of active substance and modulator in the resonator. With slow (in comparison with T) inclusion of the O-factor and with saturation of the amplification a non-modulated, smooth single-pulse is obtained that is describable by ordinary theory (a laser with an inertia-free feedback). (SJR)

12949 Laser resonator with a spacially inhomogeneous withdrawal of energy in selecting a transverse mode. Abrosimov, G.V.; Korolev, F.A.; Korolenko, P.V.; Odintsov, A.I.; Sarkarov, N.E.; Sharkov, V.F. *Zh. Prikl. Spektrosk.;* **25**: No. 1, 52-58(Jul 1976). (In Russian).

A study is made of the effectiveness of a method of improving the quality of an exit laser radiation field, which is based on selecting a higher type of oscillation in the resonator with energy withdrawal through one of the segments of the transverse field structure. A theoretical estimate is presented of the losses associated with distortion of the field during reflection from an inhomogeneous mirror. It is shown that the efficiency of the inhomogeneous mirror, which is determined as the ratio of useful transmission to the total losses of the working mode, depends strongly on the reflection coefficient of the exit part of the surface. For mirrors with straight-through openings the total losses of the working mode exceed by approximately a factor of 2 the value of the useful yield. An experimental study was carried out on the effect of spacially inhomogeneous loading on the field configuration of a carbon dioxide laser which operates in a regime of selection of higher transverse modes. The measured value of the losses introduced by inhomogeneous loading turned out to be close to the theoretical calculated value. The power characteristics of the laser were also in satisfactory agreement with theory. Experiments with energy withdrawal from a central segment of the TEM(02) mode through openings in the mirror showed that it is possible to obtain a beam with diffraction divergence. These results show that in spite of the energy losses associated with selection of higher transverse modes in a resonator with an exit opening, the systems may be of interest for infrared lasers because of such advantages as a decrease in the angular divergence of the exit beam and stabilization of the radial field structure in the resonator. (SJR)

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 12035, 12159, 12188, 12189, 12241, 12242, 12335, 12461, 12917

12950 (K/CSD/TM—15) Direct solution technique for solving steady-state problems using the HEATING5 heat transfer code. Becker, B.R. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 45p. Dep. NTIS, PC A04/MF A01.

A direct solution technique for one- and two-dimensional steady-state problems has been added to HEATING5. This technique uses a convergence criterion based upon the nodal heat residual, rather than the maximum relative change in temperature, which is the convergence criterion used by HEATING5 in the successive overrelaxation technique for steady-state problems. The direct solution technique consists of an interface subroutine, which uses the nodal configuration and effective conductances between nodes (as generated by HEATING5) to build a banded system of equations. A second routine then solves the system.

12951 (LBL—6708) Statistical study of approximations to two dimensional inviscid turbulence. Glaz, H.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1977. Contract W-7405-ENG-48. 118p. Dep. NTIS, PC A06/MF A01.

Thesis.

A numerical technique is developed for studying the ergodic and mixing hypotheses for the dynamical systems arising from the truncated Fourier transformed two-dimensional inviscid Navier-Stokes equations. This method has the advantage of exactly conserving energy and entropy (i.e., total vorticity) in the inviscid case except for numerical error in solving the ordinary differential equations. The development of the mathematical model as an approximation to a real physical (turbulent) flow and the numerical results obtained are discussed.

12952 Heat quantity counter. Raufenbarth, F. (to Zentra Albert Buerkle K.G., Schoenaich (Germany, F.R.)). German(FRG) Patent 2,521,008/A/. 18 Nov 1976. 23p. (In German).

A heat quantity counter for heating, cooling, or air-conditioning systems, with a device for measuring the temperature difference between forward and backward run of the material emitting the heat, is described. According to the invention there is an unsteady control device opening and shutting a bypass of the forward circuit and a bypass of the backward circuit; both bypasses lead through a common mixing chamber. The control device is given the average temperature between forward and backward as ideal value and compared with the true value of the mixed temperature in the mixing chamber. Each time the given positive temperature deviation the bypass of lower temperature is opened and the bypass of higher temperature is shut and vice versa. The number of the switch-overs of the by-passes is counted and is taken as a measure for the heat consumed.

12953 Possibility of using the phenomenon of "galloping" as a source of energy. Laneville, A. (Univ de Sherbrooke, Que). *Trans. Can. Soc. Mech. Eng.;* **4**: No. 1, 23-26(1976). (In French with English abstract).

For the possible use of the "galloping" of a long prism as a source of energy, the equations for the vibrations of an aerodynamically unstable bluff cylinder were established using the quasi-steady hypothesis. The work and power available during these vibrations were defined and applied to the case of a square-section bluff cylinder exposed to smooth flow. The results show that the power that could be generated from these vibrations is marginal.

12954 Experimental study of the distribution of solid particles and of the local heat transfer between the gas and solids in a two-phase flow (with one particle size). El'kin, G.I.; Timofeev, Yu.B. (Lomonosov Inst. of Food Tech., Odessa). *Heat Transfer - Sov. Res.;* **8**: No. 5, 122-126(1976).

An experimental method for study of local characteristics in a counterflow of gas and solids of uniform size is suggested. Empirical relationships for solids distribution and for the local heat transfer coefficient in the flow are given for a fairly wide range of flow-controlling factors.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 12344, 12928, 12929

12955 Sampling inspection in the non-destructive testing of boiler-tube welds. Rogerson, J.H. (Cranfield Inst of Technol, Engl). *Qual. Assur.;* 3: No. 2, 48-52(Jun 1977).

The possibility of using statistically based sampling inspection schemes for the non-destructive testing of welds in tubes for power-generation boilers has been investigated. A typical boiler may contain about 100 000 welds of similar geometry which have to be welded to a defined standard and whose quality can eventually be related to operational performance; therefore there is a potential economic advantage if the inspection of such welds can be undertaken by a controlled sampling scheme. Analyses of n.d.t. data have been used to establish typical weld defect rates and the application of various sampling by attributes schemes (A.Q.L., A.O.Q.L., and sequential schemes) has been considered. It is concluded that A.O.Q.L. schemes are the most appropriate, provided that the selection of batches of weld is made correctly.

12956 Improved images in 14.5 MeV neutron radiography. Richardson, A.E. (New Mexico State Univ., Los Cruces). *Mater. Eval.;* 35: No. 4, 52-58(Apr 1977).

The direct exposure and copper transfer methods of 14.5 MeV neutron radiography were investigated. The source of neutrons was the Texas-Nuclear Model 9505 neutron generator at the Nuclear Weapons Effects Laboratory at White Sands Missile Range (WSMR). The best radiographic contrast was obtained with the direct exposure method using Kodak Type AA Industrial X-ray film with calcium tungstate screens. The contrast sensitivity thus obtained appeared to be several times better than had been observed by earlier workers. Also, image sharpness was such that threads on bolts were clearly visible. Appreciable detail was observable in a variety of objects behind 20 cm of polyethylene. One mm diameter pins on an electronic tube were visible behind 9 cm of lead. Also, various objects were visible in a 16 mm slot in a 14 cm thick polyethylene block in front of which had been placed a 9 mm thick steel plate. This latter observation suggests using the technique for nondestructive testing of such objects as warheads and rocket motors up to several in. thick. Evidence is presented to show that the images were produced primarily by 14.5 MeV neutrons with only small, if any, contributions from gamma rays and thermal neutrons.

SAFETY ENGINEERING

REFER ALSO TO CITATION(S) 12997

VACUUM ENGINEERING

REFER ALSO TO CITATION(S) 13011

12957 (IS—4125) **Ultra purification of metals by electrotransport under outer space environmental condition. Final report, April 1, 1974—September 30, 1976.** Schmidt, F.A.; Lunde, B.K.; Williams, D.E. (Ames Lab., Iowa (USA)). 1976. Contract W-7405-ENG-82. 162p. Dep. NTIS, PC A08/MF A01.

A space simulation chamber capable of achieving pressures of 2×10^{-12} torr (N_2) was designed, fabricated, and used to develop a preprototype electrotransport experiment. It was demonstrated that the electrotransport purification of refractory metals could be successfully performed in the noncontaminating environment of an orbiting low-density materials laboratory such as the Molecular Shield Device. The zero gravity of outer space will also be advantageous since "grain-sliding" will be eliminated. As a result of the various experiments, small quantities of the world's purest thorium metal were prepared and evaluated. The electrotransport sample assembly was tested in several environments including near-zero gravity, simulated solar radiation, coldness, and darkness, and under various pressures of a representative reactive gas. Ultrapure single crystals of α thorium were prepared and are presently being characterized. Laboratory electronics for the experiment were also developed, and a totally automatic control system was used to heat the specimen. Complete assembly and line drawings of the components of the experiment and specifications for a high-current power supply are contained in the appendices.

12958 Vacuum pumping systems. Nicholls, B. (Edwards Vac Components Ltd). *Pumps;* No. 100, 570-573(Jan 1975).

The article discusses the principal design parameters of vacuum pumping systems and outlines some of the more recent developments in this increasingly complex technology. The main criteria which must be taken into account in the design of a vacuum system are the type of processes, the ultimate pressure required, the evacuation rate, the temperature at which the process is carried out and the material to be pumped.

ELECTRONIC CIRCUITS AND DEVICES

12959 (BDX—613-1740) **Feasibility of electroplated gold for hybrid microcircuits. Final report.** Blessner, P.L. (Bendix Corp., Kansas City, Mo. (USA)). Nov 1977. Contract EY-76-C-04-0613. 59p. Dep. NTIS, PC A04/MF A01.

Electroplated gold was investigated as a feasible alternative to vacuum evaporated gold for use as a conductive metallization layer on hybrid microcircuits (HMC) substrates. Conductor definition and resolution, RF electrical characteristics, via resistance, solder wettability, thermocompression bondability, and environmental stability of 6, 10 and 25 μm electroplated gold films were examined and compared to 6 μm evaporated gold films. No incompatibilities were found between electroplated gold and HMC requirements or fabrication processes.

12960 (LA-UR—77-2255) **Class of deflection-modulated, high-power microwave amplifiers.** Tallerico, P.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-771201—1). Dep. NTIS, PC A02/MF A01.

From IEEE international electron devices meeting; Washington, DC, USA (5 Dec 1977).

An unusual deflection-modulated, fast-wave electron device is analyzed. It has several unique properties; the electron beam is unbunched and is perpendicular to the direction of power flow in the circuit, and the circuit could be a simple fundamental-mode rectangular waveguide. The amplifier consists of an electron gun, a deflection cavity, an optional beam-bending system, and an output interaction region. An idealized theory showing that 100 percent electronic efficiency may be achieved, and several large-signal calculations with over 90 percent electronic and circuit efficiencies, are presented. The power, gain, and frequency limits to this type of amplifier or frequency multiplier are discussed. The beam power must be greater than 100 kW for efficient operation because the output circuit losses and deflection power depend on beam voltage, not on beam power. The devices operate best at frequencies below a few gigahertz because of limitations on the ratio of beam size to circuit size. The power gains vary between 10 and 25 dB.

12961 (UCRL—80046) **Light activated semiconductor switches.** Zucker, O.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 9p. (CONF-771132—1). Dep. NTIS, PC A02/MF A01.

From Seminar on energy storage, compression and switching; Canberra, Australia (15 Nov 1977).

Semiconductor junctions are capable of switching large power densities. As far back as the early 60's, silicon thyristors conducted 10 kA/cm^2 in the surge mode. Electric fields approaching 100 kV/cm are quite common. The single obstacle in the utilization of these devices in high power applications is the slow current rate of rise, and high power operation was attained in millisecond type applications only. The slow turn-on is due to the slow diffusion of carriers in the absence of an electric field (100 μ/μs) limiting these devices to the μs rise time regime. Light activation which involves flooding the depletion region with laser light provides for instantaneous conduction by creating the electron hole pairs necessary for conduction in situ. The potentialities both theoretical and practical for the utilization of these devices in high-power applications are discussed. In addition, open circuiting potentialities and some techniques to improve the performance and new materials are discussed.

12962 (UCRL—80313) **Analytical and experimental analysis of routing algorithms.** Kelly, M.F.; Smith, R.J. II. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Nov 1977. Contract W-7405-ENG-48. 8p. (CONF-771104—5). Dep. NTIS, PC A02/MF A01.

From 11. annual ASILOMAR conference on circuits, systems, and computers; Pacific Grove, CA, USA (7 Nov 1977).

Experiments to compare the performance of several widely used interconnection routing algorithms are described. Examples of the experimental results are given, and their implications, discussed.

12963 (SAND—77-6018) **Design and development of a high-power, 500 kV pulsed line.** Nicolas, A. (CEA Centre d'Etudes de Valduc, 21 - Is-sur-Tille (France)). Sep 1977. Translation by P. Newman of CEA-R—4733. 101p. Dep. NTIS, PC A06/MF A01.

A study was made of very high voltage (500 kV) pulse production for 50 ns at half height. A coaxial line was coupled to a Marx generator for obtaining the pulses on an impedance-adapted electron diode. The maximum power obtained was 6.4×10^{10} W with a current front in the diode of about 30 ns (80 ns pulse length at half height). (PMA)

12964 Leakage current control device. Scheuermann, R. (to Bender (W.) K.G., Gruenberg (Germany, F.R.)). German(FRG) Patent 2,436,073/A/. 19 Feb 1976. 19p. (In German).

As an addition to the patent claim 2251784.6, a leak current control device for ac systems is described, which introduces a dc voltage for measurements between network and earth into the ac system, and which responds to both directions of the dc.

12965 Complementary Josephson-junction circuit: a fast flip-flop and logic gate. Baechtold, W.; Forster, T.; Heuberger, W.; Mohr, T.O. (IBM Zurich Res Lab, Switz). *Electron. Lett.;* **11**: No. 10, 203-204(15 May 1975).

A logic circuit with Josephson junctions has been developed that operates as logic gate or as a flip-flop. Despite the latching-type characteristics of the Josephson tunnel junction, the complementary logic circuit is nonlatching. The test circuit has a power dissipation of 16.4 microwatt and a signal risetime of approximately 60 ps has been measured.

WASTE PROCESSING PLANTS AND EQUIPMENT

12966 Combustion plant especially for the combustion of refuse. Mallek, H. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,508,128/A/. 4 Nov 1976. 11p. (In German).

The patent claim describes a device for the purification of smoke gases of a combustion plant for refuse whicn separates the ash and soot particles from the hot flue gases by means of a filter. The filter layer which consists of a tissue permeable to gas (fibers made of ceramical material or of heat resistant metal) or of a solid body, is placed on a carrier with ducts or holes consisting of fireproof material. The maintenance of the filter layer is easy since it can be taken off without difficulties. The filter is arranged at the exit of the fire room.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 11661, 12818

12967 Fuel combustion apparatus. Kawaguchi, K. (to Mitsubishi Jukogyo Kabushiki Kaisha). US Patent 4,054,028. 18 Oct 1977. Priority date 6 Sep 1974, Japan. 6p.

A description is given of a fuel combustion apparatus of a double-shell construction in which the inner shell is composed of an upstream small-diameter section, a downstream large-diameter section, and a conically-shaped connecting section between the two sections of different diameters, all the sections being aligned and connected together on a common axis. Fuel injection valve and a first air supply port equipped with swirl blades surrounding the valve are provided at the upstream end of the small-diameter section of the inner shell. The cylindrical wall of the small-diameter section is not formed with any air supply port, but second air supply ports shrouded with scoops are formed in the cylindrical wall portion of the large-diameter section close to the small-diameter section. On the upstream side of the first air supply port is installed means for controlling the rate of air supply to the same port. 7 claims, 7 figures.

12968 Unconventional methods of power generation. Experimental research on aluminum-water reaction. Pittaluga, F.; Nascetti, D. (Univ di Genova, Italy). *Termotecnica (Milan);* **31**: No. 6, 306-312(Jun 1977). (In Italian).

The purpose of the study is to present the design and operation characteristics of a combustion chamber, utilizing the reaction of aluminum with water, as a function of dilution water to be converted into steam. Aluminum powder is pre-heated by means of an oxygen-propane gas stream while water is injected by means of centrifugal sprayers. The distribution of temperatures, detected by several thermocouples, comes out as a direct function of dilution ratio, thus proving the reaction is actually taking place. Steam outlet temperatures reach 600°C, while steam peak temperatures are above 1000°C. Chemical and gas-chromatographic analysis point to 88% in combustion efficiency.

12969 Package boiler or field-erected boiler. *Energie;* **29**: No. 2, 39-42(Feb 1977). (In German).

The question 'package boiler or field-erected boiler' has to include two more questions: Which fuel is available; which specific demands has the operator. In order to choose one or the other type, criteria of the different boilers have to be compared: Production time, space requirements, control equipment, maintenance, use of structural steel, energy demand, and overall costs. Only a detailed technical and economic comparison can lead to the right choice - in the contribution the 'choice aids'.

12970 Use of fluidized beds in heat treatment: possibilities and limitations. Rapsch, M. *Elektrowaerme Int., A, B;* **35**: No. B1, 38-41(Feb 1977). (In German).

A review of the development of fluidized bed technology and its potential application is presented. Specific features of the process are described. Its operating principles are well known and the process has been successfully used in other industries and also lends itself to heat treatment operations. Tests and industrial trials have shown that the costs involved in the development of fluidized bed technology and the amount of work done are fully justified. The improvements made in operating practice and in the working conditions for the operatives prove that fluidized bed processes can also be used for those heat treatment operations which so far have been the domain of salt baths. The use of fluidized bed processes in heat treatment has no impact on the environment. There are no atmospheric pollutants such as gas or vapor, no effluents from the neutralization of salts and no salt residues from washing the equipment. The cost benefits due to the absence of clarifiers or filters should also be taken into account.

12971 Heat utilization in direct-heating furnaces. Dunduchenko, V.E.; Kukarkin, A.I.; Marinskii, V.S. *Glastech. Ber.;* **50**: No. 3, 47(1977). (In German).

12972 Relationship between flame aerodynamics and the design parameters of a shaft burner. Dzyuzer, V.Y.; Pechenkin, S.I.; Kokarev, N.I. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12973 Gas burners for direct-heated tank furnaces. Kononko, V.P.; Pikashov, V.S.; Krivokon, A.A. *Glastech. Ber.;* **50**: No. 3, 47(1977). (In German).

12974 Speeding up heat-exchange processes in tank furnace with horse-shoe shaped flames. Kukarkin, A.I.; Brin'ko, P.I.; Myagkov, V.A. *Glastech. Ber.;* **50**: No. 3, 47(1977). (In German).

12975 Flameless GBP panel burners in annealing lehrs. Lisovskii, L.V.; Paller, E.Y. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12976 Investigations on low-power gas burners for heating of channels. Otto, H.; Sokolov, W. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12977 Impuls burner with high velocity of the exhaust gases. A new development of 'Gaz de France'. Rogier, J.; Douspis, M. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12978 Constructive design of burners for Siemens-Martin-furnaces. Terjung, K.; Gauter, H. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12979 Injection gas burners with pheripheral gas feed. Ustinov, A.G.; Medvedskii, V.V. *Glastech. Ber.;* **50**: No. 3, 48(1977). (In German).

12980 Radial turbine wheel for a gas turbine. Tiefenbacher, E. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,527,498/A/. 30 Dec 1976. 13p. (In German).

A possibility of improving the efficiency of gas turbines consists in the increase of live gas temperatures. This leads to higher thermal loads on turbine blades. The manufacture of suitable turbine blades was previously very expensive. In accordance with the invention a simple and cheap manufacture of such high performance turbine blades, will result where the blades are made of 2 parts with different material properties. These blades are characterized by higher heat resistance and greater strength.

12981 Furnace for the thermal processing of lumps of solid fuel. Doilow, S.K.; Efimow, V.M.; Ioonas, R.E.; Nasinin, N.A.; Piik, E.E.; Raad, H.E.; Roox, I.H.; Serebriannikow, N.D.; Schaganow, J.W.; Ananiew, L.S. (to Nauchno-Issledovatel'skij Inst. Slancev (USSR)). German(FRG) Patent 2,517,841/A/. 28 Oct 1976. 15p. (In German).

The invention is concerned with improving the slag discharge system of a furnace fired with lumps of solid fuel. It results in a fuel throughput of not more than 200 t a day being stepped up to over a 1,000 t a day. The discharge device consists of a bunker getting narrower low down with a cylindrical-bottomed water trap. Between the bottom of the bunker and the water trap lies a mobile discharge machine. Mechanically connected to the discharge ma-

chine is a scrapper which pushes the slag over the brim of the water trap bottom from where it lands on a conveyor.

12982 Combustion device for the combustion of gases generated by charging the chambers of a coke oven. Gregor, K. (to Gewerkschaft Schalker Eisenhuette Maschinenfabrik, Gelsenkirchen (Germany, F.R.)). German(FRG) Patent 2,432,464/B/. 2 Sep 1976. 4p. (In German).

Compared to other types of the device, the proposed combustion device is said to be constructed relatively simple and to be reliable in operation. The device is characterized essentially by the fact that the mixing tube ends in an end burner, i.e. the end burner is designed as a cut end (at about 45°) of the mixing tube, that the fuel supply is also designed as fuel supply tube ending in the mixing tube at an acute angle and by the fact that the burner tube is designed as a separate flame feed tube, and that the lanciform mixing tube projects into the burner tube.

12983 Untersuchungen an einer Turbinenstufe im Hinblick auf die Waermeuebergangsverhaeltnisse an einer gekuehlten Laufschaufel. (Studies on a turbine stage with regard to the heat transfer conditions on a cooled rotor blade). Kuehl, W. (Technische Hochschule Aachen (Germany, F.R.). Lehrstuhl und Inst. fuer Strahlantriebe und Turboarbeitsmaschinen). Opladen, Germany, F.R.; Westdeutscher Verl. (1976). 117p. (In German).

A combination of investigations in two parallel physical systems resulted in a method to determine local heat transfer coefficients on the gas side, which was applied to the cooled rotor blade of a test gas turbine. The interpolation nodes required for the simulation of the heat flow field in a 3-D electrical model are determined by means of temperature measurements on the rotor blade under various operating conditions. Experimental results in the Reynolds number region $Re = 0.5 \times 10^5$ and with changing flow directions yield indirect information on possible flow processes in the rotating blade channel. Only the mean values may be compared with other experimental findings; the comparison shows good agreement. When applied to the heat flow inside the turbine blades, the method yields local heat transfer coefficients on the blade edges and temperature fields of the blades.

12984 Combustion chamber for gas turbine engines. Meyer, F.J. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,403,332/A/. 7 Aug 1975. 11p. (In German).

The invention relates to a combustion chamber for gas turbine engines whose exhaust emissions are characterized by their low pollutant content. In the front region of the primary air duct bimetal strips arranged above each other like scales are installed in such a way as to admit only a small air volume into the primary air duct when the engine is idling, and a very large air volume when the engine is running at full load. This section is followed by a mixer nozzle with two concentric annular nozzle systems. Baffles are installed both between the annular nozzles and between these nozzles and the boundary walls of the primary air duct. This is followed by a prechamber closed by a flame holder. So, the invention is based on the concept of controlling the primary air fraction from the outset and admitting the balance as secondary air through apertures in the flame tube.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 11497, 11595

12985 Colloquium on drilling and blasting engineering, Clausthal 1976. Thien, P. (Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany, F.R.). Inst. fuer Bergbau). *Braunkohle;* **29**: No. 5, 202-207(May 1977). (In German).

The article gives a summary of the papers read during the colloquium, with special emphasis on the fields of drilling and blasting engineering and open-cast mining.

12986 Silicone rubber models for design and stress analysis of large components. Meyer, M.L. *J. Strain Anal.;* **11**: No. 3, 161-167(Jul 1976).

Relatively large models of soft silicone rubber sprayed with enamel paint are used successfully for initial estimates of stresses in side plates of winder drums. Results are compared with established formulae, and extended rules are indicated for initial design based on the model test result.

MARINE ENGINEERING

REFER ALSO TO CITATION(S) 11903, 13184, 13185

12987 Design and construction of offshore structures. Blanc, J.P.; Monro, M. (eds.). London; Institution of Civil Engineers (1977). 177p. (CONF-7610132—).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

Abstracts were prepared for the 17 papers presented at the conference. (MCW)

12988 Design of the deck structure for the Sea Platform Constructors (Scotland) Ltd. Gravity Production Platform. Clark, P.J.; Dawson, J.M. pp 1-7 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper covers the design of the integral deck and upper steel leg section of a concrete gravity platform for 150 m in the North Sea. It deals first with the principles which have governed the design conception and final selection of a deep plate girder solution. Key objectives have been almost exclusive use of easily available steels of conventional structural grades and thicknesses, the virtual elimination of stress relieving, minimum welding, and minimum shop and site handling. The authors deal with the alternative attractions and problems associated with box and truss decks, and give their reasons for adopting a deep plate girder solution. The steel deck design was carried out by the consultants in parallel with their drafting of the new UK Steel Bridge Code. The way in which this has influenced the design of particular elements of the deck is reported. The paper covers the application of limit state concepts where applicable, and discusses the place of both load factor and safe stress approaches in the design. Design against fatigue is dealt with in considerable detail. Several features of special interest have been selected for detail reporting. The webs of the plate girders have been designed to incorporate safely extensive holes and large cut-outs in anticipation of probable requirements, and the various stiffening systems used have been described. Solid extruded steel sections have been used to eliminate fatigue problems at web intersections.

12989 Geophysical and mechanical platform instrumentation. Bourgeois, D.; Leroy, J.P. pp 9-15 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

Offshore platform instrumentation is a new phenomenon, which started with the concept of platforms for depths of 90 to 150 m. These structures (Ekofisk tank, Forties Field jacket) necessitated much research on calculation of wave forces on the structure, hydrodynamic coefficients, distribution of strains within the structure, determination of dynamic behavior to random forces, soil response to an elastic or elasto—plastic pattern, and so on. Imprecision is allowed for in the safety factor, but a reduction of certain parameters (pile penetration depth, soil-structure surface contact for the gravity platforms) can reduce the cost of the structures considerably. This is one of the aims of instrumentation. A quick interpretation of results gives information on the basis and evolution of structural behavior. In this way it is possible to detect and deal with the fatigue phenomenon before it becomes too serious. This paper presents actual techniques of measurement for the concept of instrumentation systems and data processing.

12990 Abu Dhabi marine areas development project. McPhee, W.S.; Hussein, S.K. pp 23-30 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper discusses civil engineering aspects of a very large offshore project for reservoir pressure maintenance. Types of platforms with facilities provided together with the extent of submarine pipelines installed are briefly described. The geological and environmental conditions for the offshore location of the oilfields are outlined and the design environmental criteria summarized. The major considerations during the design stage of the platforms are examined partially with respect to the factors affecting the choice of the type of platform adopted, namely jack-up type or jacket-deck type platform. The fabrication phase discusses the reasons for the worldwide dispersal of the contracts and the material procurement and expediting functions are examined with particular reference to logistics and overall planning. Consideration is also given to the methods of transportation of fully equipped platforms and modules. Installation aspects for both jack-up and jacket-deck type platforms are discussed. The equipment used for the offshore installation is summarized. The available alternative pile installation methods are examined and the factors affecting the choice of method adopted are discussed. Finally the merits of the two types of platforms provided

in the relatively shallow waters (depth up to 35 m) are discussed particularly in light of the experience gained on the project.

12991 Design, construction and installation of the Loango steel gravity platforms. Lalli, D. pp 31-38 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper deals with the four Agip/Elf steel gravity platforms, designed by Tecnomare to be installed at Loango field (offshore Congo-Brazzaville). Water depth at location is 90 m and the platforms are designed to accommodate twelve slanted and three vertical conductors. The platforms are assembled in Europe and towed the 8500 km to the Congo in about three months. The origin of the particular structural geometry is explained together with the necessity for a gravity platform rather than a piled one. Design methods used to analyze the structure during the construction, transportation, installation, and operative phases are described. Design steps are clarified for each of the above phases, and main results are shown. Theoretical methods are also discussed. Static and dynamic behaviour of the structure is shown and design hypotheses are compared with the operative conditions during main installation and construction phases onshore, in dry dock, and offshore, in flotation. The construction phases of the platform are summarized, and main procedures are discussed in relation to the main structural parts, such as rig stiffened joints, flotation caissons, and stabilizing cylinders. Various problems concerning the types of steel used are discussed and related to the design specification and to the methods used in overcoming such problems. The construction and installation techniques are described and discussed on the basis of model test data and of the observations made during the phases mentioned above. In addition the main problems that arose during construction are analyzed and critically reviewed.

12992 Studies of offshore caissons founded on Oosterschelde sand. Rowe, P.W. (Univ. of Manchester, Eng.); Craig, W.H. pp 49-55 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The Dutch Delta Works will be completed with the largest sea dam across the Oosterschelde. For environmental reasons the inclusion of storm-surge caissons has been considered. The caissons would have to stand in 15 to 35 m of water on sand beds having initial porosities of 39 to 47 percent and would be subjected to a maximum static differential water thrust of 1.5 MN/m together with a cyclic force of +-1.9 MN/m acting 20 m above the base. In order to study the incidence of liquefaction and the effectiveness of densification methods, Rijkswaterstaat initiated a project in which an in situ test was performed by the Laboratorium voor Grondmechanica Delft (LGM) with a field model caisson and in which a number of Dutch and foreign advisers were invited to predict its behavior, for specified site conditions, to test the applicability of the methods to caisson design. LGM subjected a one-third scale field caisson to static and cyclic forces on sites both undisturbed and after ground treatment. Concurrently two series of centrifuge models were run at the Simon Engineering Laboratories, University of Manchester. The first series, run before the in situ test, gave a realistic prediction for the sand densified to 70 percent relative density. However, the initial field test on undisturbed ground showed a stage of large displacements which differed significantly from model predictions using the specified bed of 50 percent relative density. A second series of model tests, run after the in situ test but before the test data were worked out, showed that only 4 to 10 percent loose zones in the foundation could have a profound influence on temporary liquefaction and associated displacements.

12993 North Sea platform piling: development of the forties field piles from West Sole and Nigg Bay experience and tests. Fox, D.A.; Sutton, V.J.R.; Oksuzler, Y. pp 61-73 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The pile foundations of four platforms, installed in the British Petroleum Company's Forties Field during 1974 and 1975, were designed according to a philosophy and background of theory largely developed from the Company's earlier experience in the West Sole Field, described through the following sequence of events. The time taken for the piling of the original West Sole platforms was considerably extended, due to the combination of relatively light hammer with piles which were too elastic. For the further West Sole platform in 1969, pile design was directed towards making the installation less critical, leading to trouble-free completion well ahead of schedule. Details are given of the subsequent test loading of two conductor tubes driven as simulated full-scale piles to various penetrations below the sea bed. Preliminary designs for the pile foundations for the projected Forties Field platforms were being evaluated during 1971 when the most powerful hammer then available was the Menck 2500 (rated at 31,250 m tf). It was concluded that this hammer would not be capable of developing the required pile capacities. It was agreed that Menck should develop and construct a 7000 model (rated at 87,500 m tf), at that time only on the drawing board, in order to provide adequate reserve capacity for contingencies. Design of the platform leg bases and piles proceeded on the premise that the Menck 7000 would be available and tested by mid-1973. In November 1972 the production prototype Menck 7000 was brought over by derrick barge to Nigg Bay, Cromarty Firth. Details are given of the driving tests performed on instrumented, full-scale, piles complete with trial breech-block connectors. These tests facilitated the interpretation of the driving resistances developed during the piling operations.

12994 Risk analysis for offshore structures: the aims and methods. Flint, A.R. (Imperial Coll. of Science and Tech., London); Baker, M.J. pp 87-90 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The adoption of partial safety factor procedures in the current generation of structural design directives has produced a need for a rational method of determining appropriate values for the factors against collapse and unserviceability. Such a method, outlined in this paper, has been devised in the course of a project being undertaken by the Construction Industry Research and Information Association. The method, based on first order second moment reliability theory, is particularly suited to application to offshore structures, for which the principal loadings are of a random nature. The notional reliability of such structures will be examined in examples of application of the theory. The choice of safety factors should be related to the levels of structural risk acceptable from viewpoints of economics, pollution, and the risk to human life. The paper will review the range of risk levels commonly experienced and relate these to hazards arising from structural failure due to inadequacy of safety margins, finally recommending a basis for selection of an acceptable level of notional reliability. A basis for "calibration" of any design rules against existing practice is to be proposed, which is intended to ensure that construction to new directives is not, without intent, of less reliability than the least acceptable in current use. The paper will indicate the action that would be required to enable the recommended procedures to be applied to design requirements for offshore installations of steel or concrete, and will discuss the advantages which might result from the more rational drafting of safety provisions.

12995 Maritime operations relative to construction of large concrete offshore structures. Werenskiold, K. pp 97-105 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

Norwegian Contractors received their first order for a large concrete offshore structure on 14 May, 1971, and now six more platforms have been constructed. An important part of the construction of such objects is the planning and execution of the maritime operations. These can be defined as follows: preliminary investigation of towing routes, deep water sites and building dock area prior to final selection of the building site; design and installation of mooring equipment on deep water site; water filling and opening up of building dock, towage to deep water site and coupling operations to the prelaid mooring system; deck mating operations; tow-out from deep water site to the oilfield; and submergence and positioning according to contract specifications. A vast number of calculations and technical working drawings must be produced, and most of the equipment used must be designed from scratch. Time planning must be very thorough to ensure that no detail is left out which could delay operations at a critical stage. Sailing plans and navigational systems must be prepared and tested many months before the actual towing operations take place. Suitable tug boats and other ships must be chartered and close cooperation between tug boat companies and our maritime operations must be approved by Noble, Denton and Associates on behalf of the underwriters and by Norske Veritas, Lloyds, Board of Trade, harbor authorities, etc. to obtain the necessary operation permits. The maritime operation department is completely responsible for all planning and execution of the operations, and undertakes the administrative and navigational leadership on board the platforms during the entire time of operation.

12996 Liquefied gas floating facilities for offshore service. Mascaro, F. (Trans-Energy Services Ltd., London); Jansky, C.C. pp 107-

110 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper summarizes the advantages and disadvantages of four types of offshore installation designed for the storage of liquefied gas. Each particular type is analyzed in a matrix which assesses six basic components against six variables, to provide a basis for choice depending on the circumstances. A rough order of cost of three of the four types is given.

12997 Experience in prestressing and grouting concrete offshore structures. Long, J.E. pp 115-119 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The Freyssinet Group has been responsible for providing the prestressing system and equipment for eight deep water concrete gravity structures, and has actually carried out sub-contract work, normally involving tendon making, threading, stressing, and grouting, on six of these. The main purpose of this paper is to review the experience gained in executing these sub-contracts. Standard prestressing systems have been used, but major developments have resulted from the extreme lengths of the tendons involved. New equipment has been built to fabricate, handle, and thread heavy tendons, to suit the requirements of individual structures. In particular, the threading of long vertical tendons, which is not encountered in routine prestressing work, has needed an entirely fresh approach. There has been considerable development work in grouting, because there was little or no previous experience in the cement grouting of very tall vertical ducts. The background testing and development work is reviewed, and the final successful solutions to overcome the problem of bleeding, for example by making use of the strand "wick" effect to ensure complete filling, are described. Suggestions are made for future prestressed concrete gravity structure designs, based on past experience with the prestressing systems.

12998 Construction of McAlpine/sea tank gravity platforms at Ardyne Point, Argyll. Derrington, J.A. pp 121-130 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper describes the construction at Ardyne Point, Argyll, of the first three gravity concrete structures to be built in Scotland for the North Sea oil and gas fields: Frigg gas treatment platform 1, Brent oil production platform C, and Cormorant junction and production platform A. The choice and characteristics of the construction site are described, and details are given of the several stages of the construction works, both in the dry basin and afloat in Loch Striven. Concrete for all parts of the work is a grade 50 concrete having high durability and low permeability, yet containing large quantities of retarder and plasticizer to allow for delay in placing and final compaction. Results reported include strengths at twelve months. The solutions to the problems of float-out, mooring, and anchoring in the soft silt bed of Loch Striven are given and special anchors developed for this ground condition are described. The paper contains details of the mechanical works and the immersion and deck installation operations in Loch Fyne. It concludes that no major technological barriers have been encountered in the construction, except that of the massive scale of the works.

12999 Case for a hybrid. Hansen, F.J.; Ingerslev, L.C.F. pp 135-141 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The present generation of North Sea structures, installed or being constructed, can be divided into two groups: pile supported steel structures and concrete gravity structures. There are variations on the theme within each group but the distinction is quite clear. The hybrid platform, developed by RDL (North Sea) Ltd, is somewhere between these two groups. In a vertical sense it is almost 100 percent a steel jacket type of structure, whereas horizontally, in a plan view at sea bed level, it is a 100 percent concrete gravity structure. Such a structure, installed in the sea bed, combines the best of both worlds by attracting more modest wave forces and avoiding the need for pile driving. It highlights the fact that the expression "gravity" is misleading by demonstrating that stability is not primarily achieved by self weight but rather by shape and dimension, insofar as the wave action on the base, by being out of phase with the forces on the tower structure, tends to counteract them and considerably reduces the overall resultant forces to be resisted by the supporting soil strata. It also highlights the problems of the special temporary conditions during towing to site and sinking to the sea bed, where it is necessary to introduce a third element, buoyancy cylinders, to obtain floating stability at all stages and avoid excessive hydrostatic pressures on the concrete raft, the design of which should ideally be governed by the permanent loading conditions. Because the design of these three main elements is not very inter-dependent it is possible to obtain considerable freedom in the overall design and to adapt the structure to a wide range of design parameters: water depth, wave height, deck load, storage capacity, soil conditions, and available construction sites or dry dock facilities (shallow draughts are adequate).

13000 Time-temperature dependence of stresses in offshore concrete structures. Richmond, B. pp 143-150 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The particular characteristics of offshore concrete structures are related to the empirical data and theoretical frameworks produced for the differential creep/temperature aspects of the prestressed concrete pressure vessels used for nuclear reactors. The concepts of pseudo time, steady-state solution, and rate of creep are explained. They are used to determine and illuminate the way in which stresses in structures with a constant temperature distribution and applied load vary with time. Analytical, approximate, and incremental methods of solution are described. Numerical results, mainly derived by the incremental method, are presented for a series of idealized structural systems chosen to illustrate the phenomenon of differential creep in the offshore field. These include local restrained bending, the interaction due to an interface between hot oil and cold water in a cylinder, and the interaction between adjacent areas of a plane wall maintained at different temperature levels.

13001 Repair and protection of offshore structures. Tusch, K.N. pp 157-160 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The paper deals mainly with the protection of steel and concrete and also combinations of these two materials when exposed to aggressive environments such as salt water. Reference is made to the problems of corrosion protection and maintenance of the very large offshore structures used in the North Sea in connexion with oil exploration and recovery. Some specifications for protection purposes are given and mention is made of painting submerged structures.

13002 Compliant drilling and production platforms. Godfrey, P.S. pp 161-170 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The escalation in the size of conventional drilling and production platforms for deeper water and more source environments could make much of the oil discovered in such areas uneconomic to recover. Various forms of compliant platform have already been proposed as alternatives, on the basis that by yielding to the wave motions the structural requirements will be reduced. This paper examines the effects of compliance on the behavior of platforms in terms of the structural design parameters. The relative merits of time and frequency domain solutions of the dynamic equations and the effects of mass, damping, and stiffness are briefly considered. The sources of exciting forces are introduced and particular emphasis is given to the influence of various standard wave energy spectral formulations. Three illustrative examples are used to show the effects of varying these design parameters. The examples are a simplified form of potentially practical offshore platforms: a "stiff" cantilever structure, a "soft" tethered buoyant structure, and a "soft" column structure.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 12122

STIRLING

REFER ALSO TO CITATION(S) 11793

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 12781

13003 (ORNL-tr—4411) **Some considerations concerning: the physics of nuclear matter under extreme conditions and an accelerator for relativistic heavy ions.** (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.)). Jan 1977. Translation by K.S. Warren of German report. 38p. Dep. NTIS, PC A03/MF A01.

The possibilities for studying the physics of nuclear matter at high density and temperature are discussed. Topics presented include: the present situation and the future of heavy ion research; research objectives; accelerator design; and experimental facilities. (PMA)

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

13004 (LA—7010-MS) **Equilibrium phase-space distributions and space charge limits in linacs.** Lysenko, W.P. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 33p. Dep. NTIS, PC A03/MF A01.

Limits on beam current and emittance in proton and heavy ion linear accelerators resulting from space charge forces are calculated. The method involves determining equilibrium distributions in phase space using a continuous focusing, no acceleration, model in two degrees of freedom using the coordinates r and z. A nonlinear Poisson equation must be solved numerically. This procedure is a matching between the longitudinal and transverse directions to minimize the effect of longitudinal-transverse coupling which is believed to be the main problem in emittance growth due to space charge in linacs. Limits on the Clinton P. Anderson Meson Physics Facility (LAMPF) accelerator performance are calculated as an example. The beam physics is described by a few space charge parameters so that accelerators with different physical parameters can be compared in a natural way. The main result of this parameter study is that the requirement of a high-intensity beam is best fulfilled with a low-frequency accelerator whereas the requirement of a high-brightness beam is best fulfilled with a high-frequency accelerator.

13005 (ORNL-tr—4469) **Examination of the phi/sub HF/(N) and r(N) curves for different magnetic defects taken into account in calculating tolerances on the field of GANIL sectors.** Chabert, A.; Gendreau, G.; Sauret, J.; Cardin, L. (Oak Ridge National Lab., Tenn. (USA)). May 1977. Translation by T.W. Appich Jr. of GANIL 77-33-TP-04. 45p. Dep. NTIS, PC A03/MF A01.

A study is given of the beam trajectories in the presence of magnetic defects by comparing the changes in the hf phase with the radial position of the central particle of the beam. An analysis is made to determine if it is possible to assess the nature of a defect which affects the sectors from the curves provided by the phase and position probes. It is shown that in order to determine the reference radial position of the central particle, two diametrically opposed probes are required. Either three or four probes are necessary to calculate the closed orbit. (PMA)

13006 (ORNL-tr—4398) **Computer study of errors in the magnetic structure of the SSC's at GANIL. Determination of tolerances.** Chabert, A.; Gendreau, G.; Sauret, J.; Cardin, L. (Oak Ridge National Lab., Tenn. (USA)). 18 Jan 1977. Translation by E.G. Silver of GANIL CAEN 77-006-TP2. 54p. Dep. NTIS, PC A04/MF A01.

A study was made of the magnetic field tolerances allowable in the separated sector cyclotrons (Cyclotron a Secteurs Separees or CSS) at GANIL (Grand Accelerateur National a Ions Lourdes). The presentation includes: the study conditions; static and dynamic perturbations that affect the four sectors in identical fashion; and static flaws and faults that do not affect the sectors in identical fashion. A table of computer-calculated results for magnetic perturbations is given. (PMA)

13007 (ORNL-tr—4396) **Theoretical study of the errors in the magnetic structure in the SSC's at GANIL. Determination of tolerances.** Chabert, A.; Gendreau, G. (Oak Ridge National Lab., Tenn. (USA)). 8 Dec 1976. Translation by E.G. Silver of GANIL 76-79. 77p. Dep. NTIS, PC A05/MF A01.

A study was made of the magnetic field tolerances allowable in the separated sector cyclotrons (Cyclotron a Secteurs Separees or CSS) at GANIL (Grand Accelerateur National a Ions Lourdes). The presentation includes: a theoretical review; SSC characteristics; and a study of errors in the topography of the field for the accelerated orbit. (PMA)

13008 (ORNL-tr—4397) **Calculation of the magnetic dispersion in the magnets of the SSC's due to the steels of the massive magnetic circuits. First part.** Ohayon, M. (Oak Ridge National Lab., Tenn. (USA)). 1976. Translation by E.G. Silver of GANIL 76-12. 15p. Dep. NTIS, PC A02/MF A01.

Experience shows that for electromagnets constructed with massive magnetic circuits one observes large dispersion in the induction at homogeneous points of different electromagnets that are mechanically identical. These differences are evaluated for homologous points located in the central plane, based on the measured dispersion for 48 specimens derived from 24 castings. Given the size of these magnets in both volume and surface area and the subdivision into several elements, the dispersion B/sub ij/ between magnet i and magnet j is studied as a function of the electric current.

AUXILIARIES AND COMPONENTS

13009 (LA—6907) **Gyrocon: a deflection-modulated, high-power microwave amplifier.** Tallerico, P.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 23p. Dep. NTIS, PC A02/MF A01.

A large-signal, relativistic theory of the electron-field interaction in a new class of microwave amplifiers is presented and applied to the analysis of a high-power, 450-MHz amplifier for accelerator applications. The analysis indicates that electronic efficiencies in excess of 90 percent are obtainable and that overall efficiencies of 90 percent are possible. The amplifier is unique in several respects; the electron velocity is perpendicular to the circuit energy flow, the device uses a fast-wave circuit, and the electron beam is deflection modulated.

13010 (LBL—6717) **Large superconducting detector magnets with ultra thin coils for use in high energy accelerators and storage rings.** Green, M.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 13p. (CONF-770842—15). Dep. NTIS, PC A02/MF A01.

From 6. international conference on magnet technology; Bratislava, Czechoslovakia (29 Aug 1977).

The development of a new class of large superconducting solenoid magnets is described. High energy physics on colliding beam machines sometimes require the use of thin coil solenoid magnets. The development of these magnets has proceeded with the substitution of light materials for heavy materials and by increasing the current density in the coils. The Lawrence Berkeley Laboratory has developed a radical approach to the problem by having the coil operate at very high current densities. This approach and its implications are described in detail.

13011 **Modification for sealing Dependex fittings with copper.** Ekern, R. (Argonne National Lab., IL). *J. Vac. Sci. Technol.;* **14**: No. 3, 828-829(1977).

The Dependex sealing concept is a reliable O-ring vacuum seal using Viton or, in special applications, soft metal seals of indium. Dependex fittings are used extensively on accelerator beam lines where high vacuum is acceptable and high-temperature bakeouts are not routine. A method of adapting stainless-steel Dependex fittings for use with OFHC copper gaskets, a seal traditionally employed in all-metal ultrahigh-vacuum systems is described.

13012 **Ultracompact AVF cyclotron. I. Electromagnet.** Karasawa, T.; Toda, Y. *Rikagaku Kenkyusho Hokoku;* **52**: No. 5, 185-193(Sep 1976). (In Japanese).

An AVF cyclotron electromagnet, perhaps the smallest in size in the world, is described. The cyclotron can accelerate protons up to 9.4 MeV and other particles. The AVF field is four sector radial ridge type. The maximum B x R is 0.44 Wb/m and average magnetic field is 1.84 Wb/m^2. Some problems encountered at higher magnetic fields are discussed.

ION SOURCES

13013 (UCRL-Trans—11268) **100-mA source of negative hydrogen ions for accelerators.** Dimov, G.I.; Derevyankin, G.E.; Dudnikov, V.G. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). Aug 1977. Translation of IYaF—77-17. 13p. Dep. NTIS, PC A02/MF A01.

A surface-plasma source of H^- ions for accelerators was constructed. The pulse intensity of the beam formed is as high as 0.1 to 0.15 A; pulse length, 100 to 300 μsec; repetition rate, up to 100 Hz; ion energy, up to 30 keV; hydrogen consumption, 1 cm^3 torr per pulse; and cesium consumption, 0.1 g per 100 h of operation. The normalized emittances of the beam in mutually perpendicular directions are 4 x 10^{-5} cm radn x 2 x 10^{-4} cm radn in operation with fluctuations of the discharge parameters and decrease to 3 x 10^{-6} cm radn x 2 x 10^{-5} cm radn when the fluctuations are eliminated.

EXPERIMENTAL FACILITIES AND EQUIPMENT

13014 (ANL-HEP-PR—77-72) **Super magnets for interaction regions.** Biallas, G.; Fowler, W.; Diebold, R. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

The feasibility of using superconducting magnets in the beam interaction regions of particle accelerators is discussed. These higher field magnets can be shorter, leaving more room for detectors, but also must have a large aperture and magnetic shielding. The "kissing geometry" was investigated, and design and scaling considerations are given. A rough estimate of the cost of such superconducting magnets is given as an aid to the selection of interaction geometry. (PMA)

13015 (LA-tr—77-53) **Experimental complex of the meson factory of the high-current.** Barit, I.Ya.; Basargin, Yu.G.; Bondarenko, V.I. 1975. Translation by V.M. Manca of USSR report. 15p. Dep. NTIS, PC A02/MF A01.

A description is given of the experimental facilities for a meson factory having a proton and H^- linear accelerator operating at 600 MeV. The experimental complex consists of a neutral building, storage ring and buncher, meson building, beam target building, and beam transport system. A non-breeding neutron target and a high resolution π-meson dispersion channel are also discussed. (PMA)

STORAGE RINGS

REFER ALSO TO CITATION(S) 13010

13016 (LA-UR—77-1291) **Proton accumulator ring injection studies.** Cooper, R.K.; Neil, V.K. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 7p. (CONF-770709—2). Dep. NTIS, PC A02/MF A01.

From 10. international conference on high energy accelerators; Serpukhov, USSR (11 Jul 1977).

Protons may be created in an accelerator or storage ring by stripping electrons from neutral hydrogen atoms that have been injected into the machine. Because Liouville's theorem is violated by this type of injection, particles may be continually injected into a region of phase space that is already populated, and the density in that region increases with time. A computational investigation was made of the evolution of the distribution of particles in longitudinal phase space during such an injection process for a storage ring operating below the transition energy. In one calculation, an rf cavity is present in the ring and particles are injected into the stable phase region once each revolution. The purpose of this calculation is to determine the rf voltage necessary to overcome the longitudinal self-forces and contain the particles within the region of stable phase. In a second calculation, the rf is turned off, so that there is spreading in azimuth of the injected particles (i.e., de-bunching). The de-bunching occurs because of the initial energy spread and the action of the self-forces. One purpose of the calculation is to determine the total energy spread after a given number of revolutions. Another purpose is to elucidate the effect of finite resistance in the vacuum tank walls. For sufficiently high current, the finite resistance can cause bunching of a beam that is initially uniform in azimuth. Therefore it might be expected that the finite resistance would inhibit or prevent de-bunching once the number of particles injected reaches some threshold, and that this threshold would depend upon the energy spread in the beam.

13017 (SLAC-Trans—177) **High-frequency system of the VEPP-4 electron—positron storage ring, based on the gyrocon: a powerful ultrashortwave generator with an unbunched relativistic beam.** Budker, G.I.; Ganonov, V.A.; Gorniker, E.I. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). Aug 1977. Translation of USSR report. 11p. Dep. NTIS, PC A02/MF A01.

The main accelerating system of the VEPP-4 storage ring will consist of 10 cylindrical resonators supplied by a common generator, in which E_{010}-type oscillations are excited at a frequency of 181 MHz—the 221st harmonic of the rotation speed. To obtain a maximum colliding-beam energy of 2 x 8 GeV a voltage amplitude of 20 MV is required. Here the power loss in the resonator walls will amount to 2100 kW, and the power consumed for synchrotron radiation at currents of 2 x 10 mA (luminosity of 10^{30} cm^{-2} sec^{-1}) is 250 kW. At currents of 2 x 100 mA a total hf power of about 5000 kW cw will be required at maximum energy. The design and operation of the system, including the gyrocon, are described.

13018 (SLAC-Trans—178) **High-frequency configurations to raise the particle energy in PETRA.** Bathow, G.; Dwersteg, B.; Gerke, H. (Stanford Linear Accelerator Center, Calif. (USA)). 30 Jun 1977. Translation of PET—77/33. 20p. Dep. NTIS, PC A02/MF A01.

A study was made of methods to raise the energy of the PETRA storage ring beyond the 19 GeV planned for the first extension stage. A brief summary is given of the analyses, and the use of superconducting cavity resonators is discussed. It is concluded that, if energies above 23 GeV are desired, then superconducting resonators will have to be used. (PMA)

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 12213, 12236, 13153

13019 **Mosaic intrinsic germanium radioisotope scanning device with longitudinal section scanning capability.** Patton, J.A.; Price, R.R.; Brill, A.B. (Vanderbilt Univ., Nashville, Tenn. (USA). Medical Center); Pehl, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). pp 159-169 of In Medical radionuclide imaging. Vol. 1. Vienna; International Atomic Energy Agency (1977).

From IAEA symposium on medical radionuclide imaging; Los Angeles, CA, USA (25 Oct 1976).

See CONF-761060—.

A nine-element array of high purity germanium detectors has been designed and fabricated as a high resolution scanning device to be used in conjunction with radioisotopes in diagnostic studies in nuclear medicine. The detectors are 35 mm in diameter by 10 mm thick and are positioned in a 3 x 3 array with 50 mm between the centres. The energy resolution of the detectors ranges from 1.06 to 1.18 keV at 140 keV. The crystals and associated electronics are very closely matched with a maximum deviation in sensitivity of 18% from the average with collimation. The system is suspended over a computer-driven scanning bed and will remain stationary while the patient is moved in an x-y raster beneath the collimated detectors. Data are collected in a PDP-11 computer interfaced via CAMAC with capability for 2 SCA windows per detector for multiple isotope studies. Collimators are available for routine frontal plane scanning and longitudinal section tomography. The sensitivity of the system should be sufficient to permit an adequate study of the capabilities of a semiconductor scanning system in a routine clinical environment.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 11449, 12467, 12989, 13584

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 11431

NUCLEAR

REFER ALSO TO CITATION(S) 13162

13020 (LA—6914-MS) **DENBIG and DARN. Codes for the reduction of digital pinex data.** Beyer, L.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1977. Contract W-7405-ENG-36. 25p. Dep. NTIS, PC A02/MF A01.

Code DENBIG was written to reduce the digital pinex data received from the Nevada Test Site (NTS) and Transient Reactor Test Facility (TREAT) experiments. Output modes are density plots, contour plots, splatter plots, equivalent radius calculations, line cuts, and reduced data in matrix form. Provisions are included to incorporate subtraction of dry-run data, transfer function corrections, and pinhole absorption corrections. Code DARN processes pinex data in which electromagnetic pulse shifts have eliminated sync tips or caused unsaturated amplitude variations. These induced problems are eliminated by clamping the data, point by point, to dry-run data. The DARN output modes are subset of those of DENBIG. The data frame established by DARN can be filed for subsequent input to DENBIG. Program descriptions and operating instructions are discussed. 19 figures.

WEAPONRY

13021 (UCRL—50016-77-2) **Mechanical Engineering Department quarterly report, April—June 1977.** Stone, R.G.; Bathgate, M.B. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1977. Contract W-7405-ENG-48. 32p. Dep. NTIS, PC A03/MF A01.

Included are three reports. Each report was separately processed for the Energy Data Base.

13022 (UCRL—50016-77-2, pp 7-13) **Stress analysis and material certification for mechanically critical pressure transducers.** Burger, M.J.; Holten, D.C. 30 Jun 1977.

In Mechanical Engineering Department quarterly report, April—June 1977.

The Nuclear Explosives Engineering Division routinely uses pressure transducers on downhole shots at the Nevada Test Site (NTS). The transducers are of first-line criticality; their performance directly affects the experiment. The potential for total loss of a costly experiment through mechanical failure of a pressure transducer makes the highest possible mechanical integrity a routine requirement. Finite element analysis has been applied to the design and calibration of mechanically critical pressure transducers. Such analysis can quickly and inexpensively define the elastic properties of any pressure transducer. A detailed material certification program used during the transducers' manufacture further assures their reliability.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 11579, 13036, 13064

13023 (CONF-741003—, pp 167-174) **Influence of the temperature of a free-falling droplet on aerosol capture.** Styra, B.I.; Tarasyuk, N.V. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Aerosol washout by rain droplets occurs by the action of several mechanisms. The diffusional, electrical, and inertial mechanisms of aerosol capture by droplets were extensively investigated for a long time in a number of theoretical and experimental works. However, both the thermal regime of an evaporating droplet and its influence on aerosol washout by droplets have not been investigated up to now. This work is an investigation of these phenomena by means of droplet radioactivation in an air stream containing radioactive aerosols of radon decay products.

13024 (CONF-741003—, pp 183-194) **Rain scavenging of particles by electrostatic-inertial impaction and Brownian diffusion.** Beard, K.V. (Univ. of California, Los Angeles). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Numerical calculations were carried out to determine the rain scavenging rate for aerosol particles of 0.2 to 10 μm in radius on the basis of various raindrop distributions and rainfall intensities, and scavenging efficiencies were derived from the numerical collision efficiencies and experimental collection efficiencies of Beard and Grover. The resulting scavenging rates strongly reflect the inertial impaction trend of the most efficient raindrop size (1.2-mm diameter), showing a decreasing percentage of particles removed as the particle size decreases down to approximately 1 μm but then an increasing percentage due to wake capture of submicron particles. For particles approximately 0.2 μm, there appears to be a transition region where both particle inertia and Brownian diffusion are significant. Typical charges in thunderstorms markedly increase the scavenging efficiency in the gap for smaller raindrops, but the resulting scavenging rates for the assumed charge distribution are too low to be significant. Quantitative information is given for inertial impaction and Brownian diffusion efficiencies for possible incorporation into scavenging models.

13025 (CONF-741003—, pp 195-207) **Aerosol scavenging by snow: comparison of single-flake and entire-snowfall results.** Knutson, E.O.; Stockham, J.D. (IIT Research Inst., Chicago). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The efficiency of single snowflakes for scavenging of aerosol particles was determined experimentally. Single natural snowflakes were allowed to fall a known distance through a known aerosol. The individual snowflakes were recovered and examined to determine the snowflake size and crystal habit and the number of particles caught. Fourteen separate tests were done with monodisperse aerosols with diameters, D/sub p/, from 0.25 to 3.5 μm. The range of snowflake circumscribed diameters, D/sub c/, was 1 to 10 mm. The results can be represented by log E = 2.477 + 1.366 log (D/sub p// D/sub c/), where E is the scavenging efficiency. Neither crystal habit nor particle charge had a significant effect in these tests. An empirical expression for the washout coefficient was developed with the IIT Research Institute expression for single-snowflake scavenging efficiency, the Gunn-Marshall expression for snowflake size distribution, and the Locatelli and Hobbs set of expressions relating the snowflake gross diameter to its mass. The resulting expression for the washout coefficient, Λ, differed with the type of snow. As an example, for radiating assemblages of dendrites, the expression is $\Lambda = 0.32R^{0.305}$ f(D/sub p/, T) where Λ is in per second units, R is the precipitation intensity in millimeters per hour, and the function f(D/sub p/, T) is known from the single-snowflake scavenging experiment. For 25°F the above expression gives $\Lambda = 9.4 \times 10^{-6} R^{0.305}$, $7.8 \times 10^{-5} R^{0.305}$, and $4.2 \times 10^{-4} R^{0.305}$ sec for D/sub p/ = 0.5, 1.0, and 2.0 μm, respectively. The set of expressions for Λ was compared with the available data from field scavenging experiments. Satisfactory agreement was found.

13026 (CONF-741003—, pp 223-232) **Pollutant scavenging by aerosols and its effect on the cloud-nuclei budget.** Pueschel, R.F.; Weickmann, H.K. (National Oceanic and Atmospheric Administration, Boulder, CO). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Determinations of the surface elemental composition of individual particles show variations in the surface chemistry as a function of pollutant concentration and micrometeorology. This scavenging of pollutants by insoluble mineral particles affects their surface solubility and capillarity sufficiently to alter the atmospheric cloud-nuclei budget. This can result in an increased removal rate of particles from the atmosphere.

13027 (CONF-741003—, pp 233-246) **Removal processes of atmospheric aerosols and gases involving nucleation mechanisms.** Kiang, C.S. (National Center for Atmospheric Research, Boulder, CO); Mohnen, A.; Stauffer, D.; Hamill, P.; Walker, G.H. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Various nucleation processes and their roles in the removal of atmospheric aerosols and gases are discussed qualitatively and classified in two categories: (1) For relative humidity below 100%, the heteromolecular nucleation processes can be responsible for the aerosol formation; and (2) for relative humidity greater than 100%, the usual "homomolecular" heterogeneous nucleation processes are the mechanism for the formation of cloud droplets and ice crystals. A quantitative order-of-magnitude calculation for the removal of SO_2 for relative humidity below 100% by gas-to-particle conversion involving homogeneous heteromolecular nucleation is presented. Problems and defects associated with nucleation theories are also discussed.

13028 (CONF-741003—, pp 276-298) **Diffusive collection of small particles by charged raindrops.** Parker, L.W. (Mt. Auburn Research Associates, Inc., Newton, MA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The theory of convective diffusion of Brownian aerosol particles of radius a toward a raindrop of radius R falling at velocity v_0 is considered, including electric forces. Since the Peclet number Pe = Rv_0/D, where D is the aerosol diffusion coefficient, is large for drop sizes of interest, the concentration diffusion boundary layer is thin, and a boundary-layer analysis is applied at the forward stagnation point. Viscous (Stokes) and potential flows are assumed. The theoretical collection efficiency is an increasing function of drop charge Q and aerosol charge q (if any) through a charge parameter q'. If the aerosol is charged and attracted (Coulomb force), q' is proportional to vertical bar qQ vertical bar/ R. If the aerosol is uncharged (polarization force), q' is proportional to Q^2a^3/R^4. For the polarization force the concentration is not constant outside the boundary layer, and a new analysis is applied. Simple formulas are derived for the theoretical collection efficiency (e.g., proportional to a power of q'/Pe when q' much greater than Pe/sup ½/) and are verified by numerical solutions. The theory is compared with experiments by Adam and Semonin in which the measured collection efficiency of charged raindrops falling through an aerosol with undetectably small charge is proportional to drop charge. Agreement is achieved by assuming an appropriate small charge (below experimental resolution) on the aerosol. This suggests the possibility of a new detection/measurement technique for very small aerosol charges.

13029 (CONF-741003—, pp 209-310) **Collision efficiencies of drops for submicron particles: a consideration of three calculation techniques.** Mathews, L.A.; St. Amand, P. (Naval Weapons Center, China Lake, CA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Collision efficiencies are presented for the scavenging, by water drops, of submicron particles by interception and Brownian diffusion. These efficiencies are calculated for viscous flow and for potential flow by three techniques: (1) by an equation given by Smoluchowski for aerosol coagulation, (2) by the equations of Zebel and Suneja, involving diffusion boundary layers, and (3) by the stream functions and the Einstein mean-square-displacement equation. Values of collision efficiency, calculated by the last two methods, agree within a factor of 2 for both potential and viscous flow. The only advantage of the third technique over the second is that collision efficiencies for drops falling at intermediate Reynolds numbers can be calculated with relative ease through existing numerical stream functions. The first method of calculation is erroneous and, in some cases, is characterized by much smaller values of collision efficiency.

13030 (CONF-741003—, pp 311-320) **Uniformity of aerosol composition.** Peirson, D.H.; Cawse, P.A. (Atomic Energy Research Establishment, Harwell, Eng.). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Airborne particulate material is shown to have a uniform elemental composition in which the industrial elements are enriched relative to soil.

13031 (CONF-741003—, pp 662-671) **Vertical distribution of water for precipitation in a zonally averaged model.** Machta, L. (National Oceanic and Atmospheric Administration, Silver Spring, MD). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A first step in the assessment of hemispheric-scale precipitation scavenging is the determination of the spatial distribution from which precipitation originates. This paper deals with a two-dimensional grid: north-south and vertical. The flux of moisture into and out of each grid area derives from both the eddy and organized motions. The horizontal fluxes and the vertical flux due to organized motions are given by the work of Oort and Rasmusson (National Oceanic and Atmospheric Administration Professional Paper 5, 1971); the vertical eddy fluxes are estimated by the author. Global evaporation has been taken from a Soviet climatology atlas. The excess inflow over outflow to each grid box leads to a steady-state removal rate for water. The model leads to a forecast of precipitation in 5° latitude bands which can be compared with observed values.

13032 (CONF-741003—, pp 672-694) **Cloud glaciation characteristics important to parameterizing scavenging.** Koenig, L.R. (Rand Corp., Santa Monica, CA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A numerical model of cloud microphysics, emphasizing ice growth, is used to identify characteristics of glaciating clouds that may be important to scavenging processes in clouds. Glaciation is found to proceed in two stages; a long induction period, in which ice grows mainly by diffusion, followed by a shorter period of rapid conversion of the liquid content of the cloud to ice. Riming is the major growth mechanism in the latter stage. It provides a very efficient mechanism to transfer scavenged particles on small, nonprecipitating droplets to larger, precipitating ice particles. Scavenging by condensation nucleation is limited to the area of the cloud base and the last stages in the glaciation of the cloud. Scavenging by ice nucleation cn occur throughout the subfreezing portions of the cloud. Phoretic forces retard scavenging during the period of rapid glaciation; they may aid scavenging during the descent of ice below the melting level. Factors important to the control of the activity of scavenging processes are available in a model of cumulus dynamics, and it is believed that a suitable parameterization of scavenging can be included in such models. The form of the parameterization would be similar to parameterizations of microphysical processes.

13033 (CONF-741003—, pp 794-812) **Modeling rainwater contaminant concentrations due to hygroscopic particle washout.** Stensland, G.J. (Rensselaer Polytechnic Inst., Troy, NY). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A washout model has been developed which predicts instantaneous and average rainwater contaminant concentrations for a heterodisperse aerosol consisting of hygroscopic particles. Previously published washout models have not treated the details of the rainwater concentration trends, an important variable to predict because of the relative ease in collecting field data that may be useful in model verification. Results are presented to examine the effect of increasing the number of raindrop classes from 12 to 44 and the number of subcloud layers from 5 to 10 and the effect of assuming different radii for the particles released when raindrops evaporate. The model was also used to demonstrate the importance of considering raindrop time lags and to show that for some purposes a single raindrop size class yields satisfactory washout predictions.

13034 (CONF-741003—, pp 813-818) **Proposed terminology for precipitation scavenging.** Slinn, W.G.N. (Battelle Pacific Northwest Labs., Richland, WA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A list of suggested definitions for concepts in precipitation scavenging is presented. The major feature of the proposed terminology is to abandon past usage of the words "washout" and "rainout."

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11489, 12875, 12876, 12911, 13027, 13063, 13171

13035 (BNL—22998) **Temporal variation of suspended atmospheric particulates at Upton, L.I., N.Y.** SethuRaman, S.; Brown, R.M. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 3p. (CONF-771118—2). Dep. NTIS, PC A02/MF A01.

From Conference on applications of air pollution meteorology; Salt Lake City, UT, USA (Nov 1977).

Concentration of particulates in the atmosphere is generally an indicator of the presence of other pollutants, for example, sulfates and gases. Time variation of the particulates in the atmosphere was studied with an Integrating Nephelometer on the 125 meter level of the meteorological tower at Brookhaven National Laboratory. The unit was calibrated in terms of mass concentration using known amounts of oil fog and Freon gas. The particulate concentrations were continuously measured and recorded on chart paper for a period of two years--1975 and 1976. Hourly mean values were then obtained from the charts and analyzed.

13036 (CONF-741003—) **Precipitation scavenging (1974).** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Biomedical and Environmental Research). Jun 1977. 856p. Dep. NTIS, PC A99/MF A01.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

Separate abstracts were prepared for each paper. (PCS)

13037 (CONF-741003—, pp 71-87) **Scavenging ratio measurements in METROMEX.** Gatz, D.F. (Illinois State Water Survey, Urbana). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Metromex is a 5-year multiinstitutional field research program in the St. Louis area to investigate effects of urban areas on weather, especially on precipitation. As a part of this program, we collected simultaneous daily samples of precipitation and aerosols near ground level during several summer seasons at about 10 sites. Chemical analyses of collected samples were made by atomic absorption, and elemental concentrations in rain and air were computed for about seven metals. From these data, scavenging ratios (mass of element per unit mass of rain divided by mass of element per unit mass of air) were computed. Systematic relations between scavenging ratios and both meteorological and particle parameters were explored. Scavenging ratios were found to decrease from upwind to downwind of the city and to increase with the size of the scavenged particle.

13038 (CONF-741003—, pp 88-94) **Note on SO_2 scavenging in relation to precipitation type.** Summers, P.W. (Environment Canada, Toronto). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

In modeling the regional and long-range transport of pollutants, there is a need to more realistically account for the various removal mechanisms, especially precipitation scavenging. Use of precipitation sulfate measured in rain and snow in Alberta, Canada, downwind of a region with constant SO_2 emissions results in SO_2 removal rates that are related to different precipitation types and fall rates. The results indicate that the scavenging efficiency for snow is 1.5 orders of magnitude less than for rain for equivalent cloud water

contents. The scavenging rate coefficients for snow are 2 to 3 orders of magnitude less than for rain. Simple relations are proposed for the scavenging rate coefficients that, combined with the duration and type of precipitation, can be used to parameterize the precipitation scavenging sink term in transport modeling.

13039 (CONF-741003—, pp 95-117) **Formation of sulfates in clouds through the removal of sulfur dioxide and ammonia: a numerical study.** Easter, R.C.; Hobbs, P.V. (Univ. of Washington, Seattle). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The production of ammonium sulfate by oxidation of dissolved sulfur dioxide in cloud droplets in a wave-cloud situation and the resulting enhancement of cloud condensation nuclei (CCN) released from the cloud on evaporation have been calculated. The condensational growth of droplets formed on 75 initial CCN sizes is considered simultaneously with the production of sulfates via the Scott-Hobbs mechanism in the droplets in an air parcel moving through a wave cloud. The results show that significant increases in the concentrations of CCN active at 0.5% supersaturation can be produced by SO_2 oxidation in wave clouds with short "flow-through" times (4 min) and with concentrations of SO_2 and NH_3 typical of unpolluted air (1 and 3 ppB, respectively). The sulfate production is found to decrease as the SO_2 concentration rises above 10 ppB. This effect is due to the limited buffering capacity of the NH_3. The results of the calculations indicate that the in-cloud production of ammonium sulfate can probably explain previous observations of higher than ambient CCN concentrations in air from evaporating clouds and that the rate of production of ammonium sulfate in clouds is sufficiently fast that it is probably the major worldwide source of these particles.

13040 (CONF-741003—, pp 118-126) **Precipitation scavenging from a tall-stack plume.** Wiebe, H.A.; Whelpdale, D.M. (Atmospheric Environment Service, Downsview, Can.). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

An extensive research program is under way in the Sudbury area of Ontario, Canada, to evaluate the effect on the surrounding region of emissions from a 380-m smelter stack that emits an estimated 4000 Mg of SO per day and of the order of megagrams of copper, nickel, and iron. Sampling of precipitation on an event basis has been undertaken to define the magnitude of the contribution by precipitation to sulfur and trace-metal deposition within an area having a radius of approximately 50 km from the source. Initial estimates indicate that less than 1% of the sulfur emitted during a precipitation event is deposited in this area, whereas the fraction for trace metals is much higher. This rate of sulfur deposition is comparable to the background loading in the area. A comparison of the mass balance ratio of hydrogen ions to the SO_4 and NO_3 ions in the background and under-plume samples indicates that the sulfate added from plume scavenging is primarily in the acid form.

13041 (CONF-741003—, pp 127-136) **Precipitation scavenging of sulfur oxides using stable sulfur isotopes.** Kramer, J.R.; Snyder, W.R. (McMaster Univ., Hamilton, Ont.). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Sulfur-isotope analyses have been carried out on rainwater, lake water, and smelter emission samples in a 100- by 100-km study area covering the northeast emissions from Sudbury, Ontario. The smelting operations emit 1.8 to 2.4 x 10^6 metric tons annually. Stack samples of the major emission source give "del ^{34}S" ($d^{34}S$) values of 8.89‰ for H_2, SO_4, 3.96‰ particulate sulfur, and 3.23 ‰ for gaseous SO_2. Rain sample isotope values change from 4.85 ‰ at a distance of 6 km to 2.07 ‰ at a distance of 100 km in the prevailing wind direction. Lake loadings account for a concentration varying from 30 to 10 mg $liter^{-1}$ SO_4 at a distance of 10 km to 100 km from the source. The delta^{34}S of surface waters of large lakes varies from 8.49 to 2.97 ‰ at a distance of 6 and 100 km. A mass balance of delta^{34}S with the use of the above data shows that about 0.4% of the SO_2 is scavenged within about 50 km and about 1.0% within 100 km. About 76% of the H_2SO_4-^{34}S can be accounted for in the 100-km study area by a ^{34}S balance. A large drop in delta^{34}S occurs within a few kilometers of the source. The relative decrease of ^{34}S in rainwater and lake water suggests that the heavy isotope is being scavenged with little or no oxidation of SO_2 in the atmosphere.

13042 (CONF-741003—, pp 137-150) **Heterogeneous oxidation of SO_2 in relation to atmospheric scavenging.** Beilke, S. (Umweltbundesamt, Frankfurt am Main); Lamb, D.; Mueller, J. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The popular usage of simplified models that attempt to predict the oxidation behavior of atmospheric SO_2 in aqueous solution necessitates investigations into the applicability of the assumptions involved. Depending on the rate at which the oxidation takes place and the physical processes operating at the time, effects may range from acid rains to the production of effective cloud condensation nuclei. Since the effectiveness with which the atmosphere is able to remove SO_2 pollution is also strongly affected by the mechanism of oxidation, laboratory experiments were conducted to determine the chemical and physical processes involved. For interpretation of the results of the experimental data, a simple box model is used which combines the rates of several independent reactions. From this model the theoretical dependence of a normalized rate of sulfate formation on the solution ph is derived and compared with that from the experiments. The results support the hypothesis that physically dissolved SO_2 dissociates quickly to form SO_2^{2-} ions which are then oxidized to SO_4^{2-} by dissolved oxygen in the rate-determining step. On the basis of the laboratory findings and the results of previous workers, an attempt is made to develop a consistent picture of the role played by the heterogeneous oxidation of SO_2 in real atmospheric systems.

13043 (CONF-741003—, pp 151-166) **SO_2 removal by cloud and fog drops as affected by ammonia and heavy metals.** Barrie, L. (Atmospheric Environment Service of Canada, Downsview, Can.); Beilke, S.; Georgii, H.W. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The first section of ths paper deals with the influence of ammonia on SO_2 removal by clouds. The oxidation rate constant of the sulfite ion determined by experimental measurements was used in the Scott and Hobbs model to estimate the rate of sulfate formation due to SO_2 oxidation in the presence of ammonia and cloud droplets at a more realistic temperature of 3°C for a wide range of SO_2 and NH_3 concentrations. A comparison of the results with atmospheric observations leads to the conclusion that the present model does not sufficiently explain the observations and that a more realistic model is necessary. By introducing into the old model the scavenging of trace gases and the incorporation of an acidic background aerosol into the cloud water during the condensation process, discrepancies between observations and model predictions can be eliminated. If the assumptions of this new model are valid, the oxidation of SO_2 is too slow to account for cloud-water sulfate concentrations. Other conversion mechanisms operative at a pH of 4 to 5 are necessary. In the second section one possible mechanism is discussed. Experimental results of SO_2 absorption in a suspended droplet containing heavy metal salts or oxides are presented. Experiments were conducted at SO_2 concentrations typical of an urban atmosphere (0.01 to 1 ppM). The removal rate by clouds containing realistic concentrations of manganese and iron is estimated to be at least 1% hr^{-1}.

13044 (CONF-741003—, pp 175-182) **Washout of lead-containing automobile-exhaust particulates.** Dahl, D.A.; Corrin, M.L. (Colorado State Univ., Fort Collins). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The washout efficiency of 4-mm diameter water droplets for lead-containing automobile-exhaust particulates has been measured at high particulate concentrations as a function of exhaust aging time by a laboratory simulation method. Washout efficiency, in this sense, is defined in terms of removal of lead and not in particle collection by the falling droplet. The laboratory setup is described. Measurements are reported of (1) washout efficiency; (2) particle size distribution, again expressed in terms of lead; and (3) concentration of lead in the sampled atmosphere. The particle size distriution of the lead-containing particles (expressed in terms of the mass distribution of lead) is given as a function of aging time. The change in this distribution is a complex phenomenon and involves fallout, coagulation, and loss to the container walls. The effects of coagulation are evident. The washout efficiency decreases with aging time and approaches a value of 0.005 in 5 hr. The results are discussed in terms of previously published values for the lead content of rainwater. It is strongly suggested that in-cloud precipitation scavenging rather than washout is the prime mechanism for the removal in precipitation of particulate lead from automobile emissions.

13045 (CONF-741003—, pp 208-222) **Free hydrochloric acid in the atmosphere resulting from diffusion and scavenging processes.** Mohnen, V.A.; Yue, G.K. (State Univ. of New York, Albany). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The mechanism of hydrochloric acid production by nonprecipitating clouds containing sodium chloride was theoretically investigated. Four different cloud-droplet distributions have been used to estimate the amount of HCl released into the atmosphere resulting

from sulfuric acid production within the cloud droplets or absorbed from the gas phase. It is shown that the HCl production and release depend on the life cycle of the cloud and on the supersaturation of the environment. A long lifetime of a cloud and a higher supersaturation will produce more HCl.

13046 (CONF-741003—, pp 395-424) **Scavenging and dispersal of tracer by a self-propagating convective shower system.** Dingle, A.N. (Univ. of Michigan, Ann Arbor). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Indium tracer was placed in the updraft leading a moderate convective storm associated with a squall line in central Illinois. Tracer deposition was obtained from five successive regenerations of convective showers which followed the inoculated cell in regular sequence over a period of nearly 2 hr and over a distance of about 50 km. Additional tracer transport via low-level trajectories into a second system which entered the sampling network 1 hr after the inoculated system was observed and interpreted. Tracer budget analysis of the entirw rain event accounts for 42% of the initial release within the network and up to about 65% by reasonable extrapolation beyond the limits of the network. Criteria for numerical modeling of such systems, including the scavenging function, have been deduced.

13047 (CONF-741003—, pp 425-436) **Case study of plume scavenging by a rain shower.** Radke, L.F.; Hindma, E.E. II; Hobbs, P.V. (Univ. of Washington, Seattle). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The effects of rain scavenging on the aerosol plume from a large Kraft paper mill have been investigated through airborne observations. The aircraft was equipped to measure aerosol particle sizes from 0.002 to 100 μm in diameter (over a concentration range from 10^7 to 10^{-6} particles cm^{-3}); the size spectra of hydrometeors could also be measured. Measurements of aerosols in the plume unaffected by precipitation are compared with measurements in the plume when it was engulfed by a rain shower. Collection efficiencies calculated from these measurements are in reasonable agreement with theoretical calculations for particles greater than 1 μm. However, for particles smaller than 1 μm, which are not covered by previous measurements, the calculated collected efficiencies are generally much higher than the present theory predicts.

13048 (CONF-741003—, pp 437-465) **Washout of HCl and application to solid rocket exhaust clouds.** Pellett, G.L. (National Aeronautics and Space Administration, Hampton, VA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The absorption of HCl(g) by free-falling 3-mm aqueous droplets was studied experimentally with the use of four dual-shuttered chambers that contained from 10 to 10^6 parts per million by volume (ppMv) HCl(g) in N_2 at normal temperature and pressure conditions. Results (0.10- to 0.45-sec exposure) consistently fit the model of a well-stirred droplet, with absorption rate controlled by gas-phase mass-transfer resistance when HCl(g) approximately less than 10^5 ppMv. Averaged rates agreed within +-10% of values predicted by the modified Frossling equation, $Sh = 2 + 0.6\,(Re)^{0.5}\,(Sc)^{0.33}$. An analysis of solid rocket motor (SRM) exhaust cloud chemistry is followed by development of a simple model for predicting washout (scavenging by an overriding rain) of HCl(g). The Frossling correlation was applied, along with an analysis of raindrop spectra and an expression for transient decay of HCl(g) column density in a large SRM cloud (approximately 10^5 kg HCl), on the basis of an available dispersion prediction. Equations are given for rain acidity and HCl ground deposition as functions of source terms, rainfall rate, distance from launch site, and point of rain onset. Irreversible absorption applies. Localized pH's less than 2 and ground depositions exceeding 2 g HCl m^{-2} may occur within 50 km of the launch site under certain conditions. High rainfall rates close in are particularly undesirable. Refinement of predictive methodology for assessing precipitation scavenging hazards associated with the proposed space shuttle will require (1) inclusion of aerosol formation and growth on partially soluble chlorided Al_2O_3 particles under humid conditions and washout-rainout of the resulting acid aerosol, (2) verification and refinement of current SRM cloud dispersion models, and (3) analysis of convective storm dynamics in conjunction with numerous simulated SRM cloud dispersion cases.

13049 (CONF-741003—, pp 466-493) **Scavenging of aerosol particles in severe convective storms.** Kerrigan, T.C.; Rosinski, J. (National Center for Atmospheric Research, Boulder, CO). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

This paper presents a discussion of accepted in-cloud scavenging mechanisms. Two additional aspects are suggested. The first is the reaction of submicron particles to super-saturation produced by freezing drops. A calculation shows that dust particles in severe storms promote freezing drops in large numbers. Submicron particles sensitive to these super-saturations grow to sizes as ice crystals or water droplets subject to aerodynamic capture. The second aspect is the shedding of submicron- and micron-sized components of soil particles encased in water. These shed particles can represent a large fraction of the total submicron- and micron-sized particulate matter in precipitation. Calculations suggesting the relative contribution of these two aspects to the total amount of scavenged material are included. Care must be taken in interpreting scavenging data to include the contribution of these two aspects.

13050 (CONF-741003—, pp 494-502) **Aerosol scavenging in high plains thunderstorms.** Vali, G. (Univ. of Wyoming, Laramie). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Aerosol scavenging rates for rain from High Plains thunderstorms have been calculated on the basis of measured drop size distributions. The size distributions are characterized by a preponderance of large drops. A rough agreement was found between the measured hydrosol content of rain samples and the concentrations expected on the basis of the calculated scavenging rates.

13051 (CONF-741003—, pp 503-523) **Field measurements of submicron aerosol washout by rain.** Graedel, T.E.; Franey, J.P. (Bell Labs., Murray Hill, NJ). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Direct field measurements of rain washout of submicron aerosols have been accomplished by high-speed sampling of the atmospheric aerosol spectrum and the rain rate. Observed distributions of washout coefficient data for condensation nuclei and for aerosol particles in five different size ranges in the interval 0.29 μm less than or equal to d less than or equal to 3.05 μm are presented. Median values range from $1.9 \times 10^{-5}\ sec^{-1}$ for condensation nuclei to $9.2 \times 10^{-4}\ sec^{-1}$ for 1.48 μm less than or equal to d less than or equal to 3.05 μm particles. The washout coefficients increase monotonically with particle size, do not demonstrate the deep minimum near $d = 0.4$ μm predicted by theoretical studies and measured in laboratory experiments, and, for submicron sizes, are 10^2 to 10^3 larger than had been previously believed. The data suggest that electrostatic attraction between charged aerosols and raindrops may be a more important scavenging mechanism than is diffusive or impactive scavenging and that the dynamic electrical properties of the atmosphere are thereby crucial to the scavenging process. Illustrative calculations for a location with 10^3 mm annual rainfall indicate that average lifetimes due to washout range from several tens of hours for submicron aerosols to about 20 days for condensation nuclei. The derived values are directly applicable to studies of tropospheric chemical cycles, aerosol chemistry, circumglobal dust transport, optimum siting of power plants, atmospheric radioisotope cycles, and climatic change.

13052 (CONF-741003—, pp 524-530) **Trace-element enrichment of sea spray.** Peirson, D.H.; Cambray, R.S. (Atomic Energy Research Establishment, Harwell, Eng.). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

In the surface of the North Sea, the trace-element content appears to be greatly enhanced relative to bulk seawater.

13053 (CONF-741003—, pp 531-551) **Variability of rainwater composition and errors in estimates of areal wet deposition.** Granat, L. (Univ. of Stockholm). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Rain chemistry data--including several monthly samples from about 50 collectors placed at distances typically from 20 to 50 km, a few daily samples with about 150 collectors placed in an area of 100 by 100 km, and data from the European Atmospheric Chemistry Network--are used to reveal important features in the deposition field for up to nine major constitutents in rainwater. These data provide a foundation for a proper evaluation of already-accumulated rain chemistry data from the European Atmospheric Chemistry Network, as well as useful information on network design intended primarily for monitoring large-scale deposition but also for investigating local fallout on short-term basis.

13054 (CONF-741003—, pp 552-570) **Precipitation as a source of nutrients for terrestrial and aquatic ecosystems.** Likens, G.E.; Eaton, J.S.; Galloway, J.N. (Cornell Univ., Ithaca, NY). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The input of nutrients and other chemicals via rain and snow may have significant ecological effects on natural ecosystems. Precipitation is a major source of nutrients for many terrestrial ecosystems, and inputs of inorganic nitrogen and phosphorus may exceed losses in drainage waters. Direct precipitation is also a major source of nutrients for lakes, particularly where the watershed is undisturbed and the ratio of lake surface area to drainage area is large. Precipitation may account for some 40 to 55% of the phosphorus and 45 to 75% of the inorganic nitrogen input for some oligotrophic lakes. Smaller percentages, but significant amounts, of nitrogen and phosphorus are contributed by precipitation to various culturally eutrophic lakes. No long-term records of phosphorus in precipitation exist for the United States, but nitrate concentrations have increased some 2.5- to 3-fold in the northeastern United Stated since 1945. Inputs of acid, heavy metals, pesticides, and other toxicants in precipitation may have serious ecological implications for natural ecosystems.

13055 (CONF-741003—, pp 571-589) **Horizontal interception in high-elevation ecosystems of New England.** Reiners, W.A.; Schlesinger, W.H.; Marks, R.H. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

High-elevation ecosystems of New England are exposed to high winds and persistent clouds. Such conditions are conducive to deposition of aerosols and water on intercepting surfaces through a variety of microphysical processes. This deposition through horizontal interception may significantly exceed deposition measured in standard collectors. To estimate the magnitude of horizontal interception, we installed five paired collectors on a highly exposed site near the tree line. Each pair consisted of one open bucket and one bucket with attached artificial conifer foliage. Data indicated that water capture by the collectors with foliage was 4.5 times higher than capture by the open buckets and that cation capture ranged from 5.5 to 8.3 times higher. Deposition rates for lead suggested environmental exposures in the range of urban areas. Analysis of lead in surface soils supported evidence for these exposures and suggested an elevational pattern of deposition rates.

13056 (CONF-741003—, pp 590-601) **Precipitation scavenging in central and northern Ontario.** Muller, E.F. (McMaster Univ., Hamilton, Ont.); Kramer, J.R. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Time-averaged deposition of SO_4, Fe, Ni, and Cu are presented and discussed in view of the industrial mining and smelting activities and associated atmospheric emissions in central Ontario for the period 1970 to 1974. Deposition rates compared for the periods after and prior to the installation of a 381-m stack of a main smelter complex in Sudbury show an increase of depositional area, but less deposition near the source. Deposition rates are shown to be highest in the Sudbury area and decrease with increasing distance from Sudbury. Deposition rates decrease in the following order: Fe > Ni > Cu much greater than SO_4; material balance of emitted vs. deposited materials shows removals from 100 to 0.5%.

13057 (CONF-741003—, pp 602-610) **Acid rain in Puget Sound.** Harrison, H.; Charlson, R.J.; Christian, G.D.; Horike, N.; Knudson, E.J.; Larson, T.V.; Riley, H.; Vanderwort, R.; Weiss, R. (Univ. of Washington, Seattle). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

In Seattle we have measured rain pH with means near 4.5 and extremes of 3.2 and 6.6. The pH varies rapidly and apparently randomly within single rain episodes. Low pH correlates with southerly wind direction, ambient SO_2, and the air's aerosol content as measured by optical scattering. In the Puget Sound Basin, one well-studied storm shows integrated washout patterns wherein pH correlates with sulfate, antimony, and arsenic (but not with several other trace metals) or with nitrate or chloride. The plume pattern clearly originates at a local smelter. Our rain showing lowest pH cannot be in equilibrium with ambient ammonia at concentrations higher than 0.1 ppB. Our rain with highest pH exceeds the value of the air's carbon dioxide buffer. In laboratory studies we have shown that the rate of heterogeneous oxidation of aqueous sulfur(IV) species by dissolved oxygen, in the absence of metal catalysts, cannot be described as simply proportional to sulfite-ion concentration. An additional negative rate effect is observed at low pH (less than 6) and a positive one at high pH (greater than 8). In acidic urban smog, this process cannot account for observed conversion rates of sulfur dioxide to sulfate aerosols.

13058 (CONF-741003—, pp 611-624) **Chemical analysis of south Florida's environment.** Wisniewski, J. (Univ. of Virginia, Charlottesville); Cotton, W.R. Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A total of 280 rainwater samples were collected over South Florida during the 1973 Florida Area Cumulus Experiment (FACE). These samples were collected both on the surface and at the cloud-base level (600 m) aboard the NOAA-DC6 (39C) aircraft. All 280 samples were analyzed for silver and lead concentrations. Twenty-four were analyzed for five inorganic nonmetallic pollutants (SO_3, SO_4, NO_2, NO_3, and NH_4) and pH. Approximately 100 were analyzed for pH and four of the species mentioned above, five common ions (sodium, potassium, magnesium, calcium, and chlorine), ortho-PO_4, and total dissolved iron. These analyses are discussed with regard to variations between cloud-base peninsula samples, cloud-base marine samples, surface rural samples, and surface urban (Miami) samples. Comparisons of results with other sampling networks are discussed. A more extensive and continuous 2-year surface rainwater collection network began operations during mid-July 1974 in South Florida. Rainwater is being collected by several groups; the National Oceanic and Atmospheric Administration (NOAA) Laboratories, the Central and South Florida Flood Control District, the U.S. Army Corps of Engineers, and the Everglades National Park Service. Samples are being analyzed at the Central and South Florida Flood Control Laboratories. Analyses for SiO_2, total PO_4, and alkalinity have been added to the 1973 list of chemical constituents. The network and preliminary results are discussed. Some general problems to be aware of when designing and operating a rainwater collection network are discussed. Specific examples from the South Florida studies are given.

13059 (CONF-741003—, pp 639-661) **Statistical evaluation of the U.S. precipitation chemistry network.** Miller, J.M. (National Oceanic and Atmospheric Administration, Silver Spring, MD). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Precipitation chemistry data collected between January 1972 and December 1973 from the U.S. Precipitation Chemistry Network are statistically evaluated in terms of the data themselves and simultaneous measurements by independent groups. Lead, nickel, manganese, iron, and cadmium were below detection during 73 to 92% of the 2-year period and were disregarded. Measurements of sulfate, nitrate, ammonium, chloride, fluoride, calcium, copper, potassium, magnesium, sodium, zinc, and the pH were averaged and correlated to give a distribution of these constituents over the United States. These distributions are compared to those of past networks and other independent measurements. On the basis of the data collected, a strong case can be made for the need to improve siting, collection, and analysis so as to produce reliable data from the U.S. Precipitation Chemistry Network.

13060 (UCRL—79484) **Astronomical techniques applied to pollution detection: 1. Pollution transport.** Porch, W.M.; Sherman, C.A.; Dickerson, M.H.; Green, T.; Volker, P.; Waidl, J.; Galloway, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 6p. (CONF-771113—3). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

An astronomical observatory located below the urban inversion in Oakland, California has been recently used as a remote sensing facility for detection of urban aerosol and molecular pollution and transport analysis. These measurements were made with a sixteen element photodiode array close to the focus of a twenty inch refracting telescope detecting visible light extinction and refraction from stellar and artificial light sources. Atmospheric transport was determined by using the time lagged covariance of the scintillation from artificial light sources at several diode separations to determine the space averaged winds which were subsequently included in a wind field model of the Bay Area including topographical effects. The results of this study demonstrate the compatibility of remotely sensed spatially averaged wind measurements as input data to mesoscale models for interpretation of pollution transport.

13061 **New construction of an optical dustmeter.** Slowinski, Z. *Staub-Reinhalt. Luft;* **37**: No. 6, 232-234(Jun 1977).

The construction and principle of operation of a dustmeter is described. The dustmeter works on the basis of extinction of light passing the dusty medium. The device is suitable for continuous measurements of dust concentration in chimneys.

13062 **Global atmospheric consequences of the combustion of fossil fuels.** Deague, T.K. *J. Inst. Fuel;* **48**: 153-162(Sep 1975).

On the basis of this detailed examination it is concluded that there is at present insufficient evidence to confirm or refute the

proposition that fossil fuel consumption will cause a catastrophic change in global temperature over the next few decades.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11490, 12415, 12482, 13078, 13089, 13167

13063 (CONF-741003—, pp 61-70) **Scavenging ratios.** Krey, P.W.; Toonkel, L.E. (Health and Safety Lab., New York). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Total ^{90}Sr fallout is adjusted for dry deposition, and scavenging ratios are calculated at Seattle, New York, and Fayetteville, Ark. Stable-lead scavenging ratios are also presented for New York. These ratios show large scatter, but average values are generally inversely proportional to precipitation. Stable-lead ratios decrease more rapidly with precipitation than do those of ^{90}Sr, a decrease reflecting a lesser availability of lead to the scavenging processes.

13064 (CONF-741003—, pp 321-336) **Review of chemical-tracer experiments on precipitation systems.** Gatz, D.F. (Illinois State Water Survey, Urbana). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

Experiments involving the introduction of tracer materials into precipitation systems for the purpose of tracing the motions of air and/or hydrometeors within them began in the USSR in 1964. Since then approximately 100 such experiments have been performed. Most experiments have been performed on convective clouds, but the frontal-layer-type cloud systems of the northwest United States coast have also been the object of tracer experiments. The tracers have been released mostly from aircraft, but ground generators and rockets have also been used. At least 13 different elements or isotopes have been used as tracers. Although many recent experiments have been reported only in a limited way, a general picture of cycling times, deposition areas, and tracer-removal efficiencies is beginning to develop.

13065 (CONF-741003—, pp 382-394) **Radon daughters and fission products as atmospheric tracers.** Beck, J.N.; Daniel, P.Y.; Nevissi, A.; Meason, J.L.; Kuroda, P.K. (Univ. of Arkansas, Fayetteville). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

The concentrations of ^{89}Sr and ^{90}Sr were measured in the entire series of rain and snow samples collected at Fayetteville (36°N, 94°W), Ark., during the period August 1971 to June 1973. Measurements were also made on some rain samples collected at Tokyo (36°N, 140°E), Japan, and at Ankara (40°N, 33°E), Turkey. Three nuclear tests were conducted in Lop Nor (40°N, 90°E), China, while this study was being made: 12th (Nov. 18, 1971), 13th (Jan. 7, 1972), and 14th (Mar. 18, 1972). The "cycling" effect of the fresh debris was clearly observed after the 14th Chinese test: Peaks in the $^{89}Sr/^{90}Sr$ ratio occurred successively at Fayetteville (94°W), Ankara (33°E), and Tokyo (140°E), in that order, indicating that the freshly injected debris traveled eastward, circling the world at least twice until the distribution of the fission products in the troposphere became more or less uniform after about 2 months. Values of the residence time of ^{90}Sr in the troposphere were calculated from the $^{89}Sr/^{90}Sr$ ratio data. Although the debris from the 12th and 13th tests yielded rather short apparent residence times of about 7 +- 3 days and 16 +- 3 days, respectively, much longer and approximately concordant mean residence times were obtained from the $^{89}Sr/^{90}Sr$ and $^{210}Po/^{210}Pb$ ratios measured simultaneously in many of the rain samples collected after the 14th test. The results indicate that most of the ^{210}Po originated from the decay of ^{222}Rn in the troposphere. The experimental data obtained in this work are consistent with the mean residence time of ^{90}Sr in the stratosphere of approximately 1 year.

13066 (CONF-741003—, pp 695-731) **Precipitation scavenging model for nuclear fallout research.** Norment, H.G. (Mt. Auburn Research Associates, Newton, MA). Jun 1977.

From Precipitation scavenging conference; Champaign, IL, USA (13 Oct 1974).

In Precipitation scavenging (1974).

A precipitation scavenging capability has been developed for the DELFIC fallout prediction code. The DELFIC Precipitation Scavenging Module (PSM) consists of: (1) A kinematic storm-cloud circulation model; (2) cloud microphysics models for water and ice; (3) aerosol scavenging models. Atmospheric transport of nuclear cloud particles into the storm and transport of scavenged particles (as hydrometeor-particle combinations) from the cloud are accomplished with a modified DELFIC transport calculation. The microphysics models are based on Kessler's parameterizations for water and Koenig's parameterizations for ice. Scavenging is by the following mechanisms: (1) Below-cloud: inertial collection by precipitation; (2) in-cloud: (a) Nucleation and condensation growth of water drops or ice crystals coincident with inertial collection of the growing particles by precipitation, and (b) Brownian scavenging by cloud-water drops coincident with inertial collection of the cloud water by precipitation. Phoretic scavenging is not included because it is too slow to lead to militarily significant, local, ground deposition of fallout. Calculations for a rainstorm that yields 20 mm hr^{-1} precipitation at the ground indicate a below-cloud aerosol scavenging threshold between 1.5 and 2.0 μm in diameter. An in-cloud threshold of 0.3 μm is indicated. Calculations for a snowstorm that yields 10 mm hr^{-1} precipitation at the ground indicates similar results below cloud but an in-cloud threshold of approximately 0.02 μm. Interactions of nuclear and storm clouds are discussed. Intermediate scavenging results and final ground-deposition results are presented.

13067 (EPA—520/4-77-005) **Radiation protection activities, 1976.** (Environmental Protection Agency, Washington, D.C. (USA). Office of Radiation Programs). Aug 1977. 169p. Protection Agency, Washington, DC.

Separate abstracts were prepared for seven sections of this report. A list of radiation protection publications during 1976 is included.

13068 (EPA—520/4-77-005, pp 7-24) **Naturally-occurring radioactive materials.** Aug 1977.

In Radiation protection activities, 1976.

Radiation protection activities during 1976 reported include the assessment of health and environmental problems associated with sources of natural radioactivity. Sources discussed include: uranium mill tailings disposal sites; radon in drinking water supplies; levels of radioactivity in caves supervised by the National Park Service; radioactivity in phosphate rocks used for fertilizers and construction materials. The preparation of a bibliography on radioactivity in fossil fuels is reported and the impact of the 1976 Toxic Substances Control Act and the Resource Conservation and Recovery Act on recommendations concerning exposure to naturally-occurring radioactive materials is discussed.

13069 (EPA—520/4-77-005, pp 43-83) **Nuclear power.** Aug 1977.

In Radiation protection activities, 1976.

Radiation hazards from nuclear power plants, including reactor operations, nuclear fuel preparation, and radioactive waste disposal are reviewed. Measures for the protection of the public are discussed.

13070 **Radiological significance of transuranium radioisotopes released to the environment during operation of the LMFBR fuel cycle.** Barr, N.F. (Energy Research and Development Administration, Washington, D.C. (USA)). pp 649-655 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

Estimates based on current knowledge and conservative assumptions indicate that release of transuranium elements from the Liquid Metal Fast Breeder Reactor (LMFBR) fuel cycle are likely to proaduce population dose commitments small compared to those produced by naturally occurring alpha emitters and globally dispersed transuranium radioisotopes from tests of nuclear weapons in the atmosphere. Potential health consequences of these releases to current and future generations are estimated to be very small compared to risks associated with the production of energy by fossil fuels. The estimates are subject to a number of uncertainties imposed by lack of knowledge. Some of the uncertainties are not likely to be greatly reduced until LMFBR facilities are designed and operated. Others may be significantly reduced prior to facility design and operation. The paper discusses the sensitivity of the estimates to uncertainties and approches to reducing those uncertainties that strongly influence the estimates.

13071 (SAND—77-0854C) **Simulated atmospheric disperison of radioactive material released in an urban area.** Akins, R.E.; Church, H.W.; Tierney, M.S. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 4p. (CONF-771113—5). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

A combination of Gaussian plume and particle-in-cell techniques is used to simulate the atmospheric transport and dispersion of a puff release of radioactive material. The release is caused by an accident that is assumed to occur during the shipment of the radioac-

tive material through central New York City. The simulation provides estimates of volumetric and surface concentrations of the dispersed material that are used to predict radiation doses incurred by the City's population in the event of an accidental release. In the simulation, the release point is arbitrary and the material is assumed to be either a gas or fine particles. The Gaussian plume model follows cloud concentrations from the release time until times when transport over distances up to 500 m has been achieved. The released cloud may stabilize at street level or above the mean buildings height; at a street intersection or in the middle of the block. The possibility of the formation of multiple clouds, owing to circumstances of wind flow direction and street geometry, is allowed.

13072 Simulation modelling of environmental transport and health consequences of radioactive effluents from nuclear power systems. Cuddihy, R.G.; McClellan, R.O. (Inhalation Toxicology Research Inst., Lovelace Biomedical and Environmental Research Inst., Albuquerque, N. Mex., USA); Chapman, L.D.; Wayland, J.R.; Dugan, V.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). pp 657-666 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

Developing programs for widespread production of electrical power from nuclear reactor systems require detailed analyses of anticipated radioactivity releases, environmental contamination and potential impact upon human health. This report describes a simulation model of the environment, including man, developed to study evaluations of risks associated with radioactive releases from nuclear fuel cycle facilities. The model provides predictions of the time-related development of potential health effects in human populations and facilitates the determination of the sensitivity of resulting risk estimates to the many rate constants, physical variables and siting assumptions incorporated into the model. Initial modelling efforts have been directed toward releases of transuranic elements from the Liquid Metal Fast Breeder Reactor fuel cycle including ^{238}Pu, ^{239}Pu, ^{240}Pm, ^{241}Am, ^{242}Cm and ^{244}Cm. Output from the model includes estimates of turor and genetic defect incidences related to projected growth of nuclear reactor program through future generations. This information and the sensitivity analyses are directed toward determining the more important model pathways to man and identifying areas of the analysis where fundamental information is lacking.

REGULATIONS

REFER ALSO TO CITATION(S) 12556

ENVIRONMENTAL SCIENCES, TERRESTRIAL

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 13171

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11490, 11753, 12913, 13067, 13068, 13070, 13086, 13167

13073 (BNWL—2117, pp 39-71) **Actinide occurrences in sediments following ground disposal of acid wastes at 216-Z-9.** Ames, L.L. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

Liquid acid wastes from a Pu recovery facility at Hanford were released to the ground via structures collectively termed trenches from 1955 through 1962. Data are presented from a study of the microdistribution of Am and Pu in samples from the 216-Z-9 trench. Solution sediment relationships and associated actinide removal mechanisms under acid conditions were studied. Core wells were drilled into the sediments in which this covered trench is located and in the immediate vicinity to obtain samples for quantitative mineralogical analysis and comparison of sediments from various depths of contaminated and noncontaminated areas. Analytical techniques are described and results are reported.

13074 (BNWL—2117, pp 73-101) **Migration of Pu and Am.** Friedman, A.M.; Fried, A.; Hines, J.; Quarterman, L. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

Results are reported from studies on the mechanisms involved in the migration of long-lived isotopes of Pu and Am released from radioactive waste depositories through fissures or pores in rocks and soils. The surface absorption coefficients of Pu and Am were measured in a static system by equilibrating solid samples of stone (solid cores of Los Alamos tuff and Idaho basalt) of known surface area with solutions of Pu or Am in the appropriate chemical milieu. It was shown that the static coefficients and physical constants of the system were sufficient to predict the distance migrated. A computer model of Pu and Am migration was developed.

13075 (BNWL—2117, pp 225-254) **Plutonium and americium behavior in the soil/water environment. I. Sorption of plutonium and americium by soils.** Glover, P.A.; Miner, F.J.; Polzer, W.L. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

Results are reported from studies on the relationships between the chemical and physical characteristics of soils and their sorption of Pu and Am isotopes. Data are reported from equilibrium sorption measurements using 17 soils from various locations and Pu and aAm nitrates as the source of the actinides.

13076 (BNWL—2117, pp 255-290) **Plutonium ad americium behavior in the soil/water environment. II. The effect of selected chemical and physical characteristics of aqueous plutonium and americium on their sorption by soils.** Polzer, W.L.; Miner, F.J. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

In order to explain changes in sorption of actinides by soils relative to the concentration of the actinide in the system, observations were made with respect to selected chemical and physical characteristics of the actinide in solution and the sorption of the actinide by soils. Sorption is discussed in relation to: the relative concentration of the various aqueous actinide specie; polymerization of aqueous actinides: and the formation of complexes with other ions. Most experimental work on aqueous actinides has been conducted under conditions unlike those in a soil/water environment, therefore, the evluation necessarily involves theoretical as well as experimental considerations.

SOIL

13077 Mass isotopic composition of global fall-out plutonium in soil. Krey, P.W.; Hardy, E.P. (Energy Research and Development Administration, New York (USA). Health and Safety Lab.); Pachucki, C.; Rourke, F.; Coluzza, J. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA); General Electric Co., Schenectady, N.Y. (USA)); Benson, W.K. (Energy Research and Development Administration, Washington, D.C. (USA)). pp 671-677 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

The mass isotopic content of fallout plutonium in soil samples collected from around the world in 1970 and 1971 showed some variability which correlated with the location of nuclear weapons test sites. Omitting local effects, the global mean ratios of $^{240}Pu/^{239}Pu$, $^{241}Pu/^{239}Pu$ and $^{242}Pu/^{239}Pu$ are 0.176+-0.014, 0.0086+-0.0017 and 0.0044+-0.0011, respectively, corrected to January 1971. Such isotopic data provide the most sensitive technique to resolve mixtures of fallout plutonium with plutonium from a second source. From these data, the ^{241}Am/sup(239,240)Pu activity ratio of integrated fallout on the earth's surface can be estimated and will peak at 0.42 in the year 2037.

13078 Measured plutonium resuspension and resulting dose from agricultural operations on an old field at the Savannah River Plant in the southeastern United States of America. Milham, R.C.; Schubert, J.F.; Watts, J.R.; Boni, A.L.; Corey, J.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). pp p.409-420 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

Plutonium resuspension, based on air-sample activity, were measured during field preparation and planting of winter wheat at the Savannah River Plant (SRP). Plutonium was originally deposited

in the field during the previous twenty years as a result of atmospheric releases from SRP's nuclear fuel processing facility located adjacent to the field, and from global fall-out following nuclear weapons tests conducted at other sites. During soil cultivation when the prevailing wind speed ranged from 0 to 6.3 m/s airborne plutonium upwind of the field consistently averaged 1.7 fCi/m^3. Airborne plutonium concentrations during the various activities associated with site preparation and planting averaged 210 fCi/m^3 at 7.6 m and 10 fCi/m^3 at 30.5 m downwind from the edge of the field. The air at face level on the tractor contained 49 fCi/m^3. The average concentration of plutonium in the 0-5 cm soil layer following cultivation was 3100 fCi/g. Dose calculations based on measurements of resuspended plutonium indicated that the 70-year bone-dose commitment to an agricultural worker after one hundred 8-hour days would be 49, 210 or 1.8 mrem, depending on whether the worker remained in the tractor seat, 7.6 m downwind of the edge of the field or 7.6 m upwind of the edge of the field. Resuspension factors for the agricultural activities were $103 \times 10^{-8} m^{-1}$ at 7.6 m downwind, $5 \times 10^{-8} m^{-1}$ at 30.5 m downwind from the edge of the field, and $24 \times 10^{-8} m^{-1}$ at the tractor location.

13079 Plutonium and americium in soils of Bikini Atoll. Nevissi, A.; Schell, W.R.; Nelson, V.A. (Washington Univ., Seattle (USA). Coll. of Fisheries; Washington Univ., Seattle (USA). Lab. of Radiation Ecology). pp 691-700 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

A study has been made to determine the concentrations of plutonium and americium in surface soils and in soil profiles on Bikini Atoll. The soils consist of calcareous materials and a thin layer of organic matter, which has produced a shallow, organically rich horizon suitable for certain plant growth. During the testing period from 1946 through 1958 Bikini Atoll was the site of 23 nuclear detonations, which contaminated the islands of the atoll with radioactive fall-out, including the transuranium elements. Plutonium and americium measurements of surface soil samples collected on 6 of the 26 islands of the atoll show that sup(239,240)Pu values vary from 0.5 to 360 pCi/g and ^{241}Am values from 1.2 to 45 pCi/g. The vertical distribution of plutonium in soil varies from area to area. Although about 98% of the plutonium is retained in the top 25 cm in one core profile, the remaining 2% is detectable as deep as 100 cm. The suspension and resuspension of plutonium and plutonium-bearing particles by rainwater (150 to 175 cm/a) seems to be the principal mode of plutonium transport in the soil. Plutonium is found associated with the algal crust of the atoll soils. The present concentrations of sup(239,240)Pu and their distribution at Bikini are not likely to change significantly, whereas ^{241}Am concentrations will increase by ^{241}Pu decay and will approach a maximum value in about 50 years.

13080 Characterization of actinide-bearing sediments underlying liquid waste disposal facilities at Hanford. Price, S.M. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)); Ames, L.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 191-210 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

Past liquid waste disposal practices at the US Energy Research and Development Administration's Hanford Reservation have included the discharges of solutions containing low concentrations of actinides directly into the ground via structures collectively termed "trenches". Characterization of samples from two of these trenches, the 216-Z-9 and the 216-Z-1A(a), has been initiated to determine the present form and migration potential of plutonium stored in sediments which received high salt, acidic waste liquids. Analysis of samples acquired by drilling has revealed that the greatest measured concentration of plutonium, approximately 10^6 μCi ^{239}Pu/l of sediment, occurs in both facilities just below the points of release of the waste liquids. This concentration decreases to approximately 10^3 μCi ^{239}Pu/l of sediment within the first 2 m of the underlying sediment columns and to approximately 10 μCi ^{239}Pu/l of sediment at the maximum depth sampled (9m). Examination of relatively undisturbed sediment cores illustrated two types of Pu occurrence responsible for this distribution. One of these types is composed of Pu particles (>70 wt% PuO_2) added to the disposal site in the same form. This "particulate" type was "filtered out" within the upper 1 m of the sediment column, accounting for the high concentration of Pu/l of sediment in this region. The second type of Pu (<0.5 wt% PuO_2) was originally disposed of as soluble Pu(IV). This "nonparticulate" type penetrated deeper within the sediment profile and was deposited in association with silicate hydrolysis of the sediment fragments.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 12415, 13072

13081 Plutonium transport and dose estimation model. Martin, W.E.; Bloom, S.G. (Battelle Columbus Labs., Ohio (USA)). pp 385-398 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

A Standard Man is assumed to live in and obtain most of his food from a Pu-contaminated area at NTS. A Pu-transport model, based on the results of other studies at NTS, provides a basis for estimating rates of ^{239}Pu inhalation and ingestion as functions of the average concentration of ^{239}Pu (Csub(s)=pCi/g) in the surface soil of the reference area. Assuming the transport system to be in equilibrium, the estimated inhalation and ingestion rates (pCi/d) are 0.002Csub(s) and 0.269Csub(s), respectively. A dose estimation model, based on parameters recommended in ICRP publications, is used to estimate organ burdens, accumulated doses, and dose commitments as functions of exposure time. Estimated doses (rems) due to inhalation and ingestion of ^{239}Pu for 50 years at the rates indicated above are: thoracic lymph nodes. 0.6Csub(s); lung, 0.025Csub(s); bone, 0.015Csub(s); liver, 0.01Csub(s); kidneys, 0.003Csub(s); total body, 0.0007Csub(s); and gastrointestinal tract (LLI), 0.0003Csub(s); Inhalation accounts for 100% of the predicted dose to thoracic lymph nodes and lungs and for about 94% of the predicted dose to bone, liver, kidneys, and total body. According to ICRP recommendations for individual members of the public, the dose rate to the lungs should not exceed 1.5rem/a. According to the proposed model, the average concentration of ^{239}Pu in the soils of contaminated areas at NTS which would result in a predicted dose rate of 1.5rem/a to the lung is approximately 3nCi/g or about 170μCi/m^2.

13082 Relationships among plutonium contents of soil, vegetation and animals collected on and adjacent to an integrated nuclear complex in the humid southeastern United States of America. McLendon, H.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Plant); Stewart, O.M. (US Department of Agriculture, Aiken, South Carolina, USA); Boni, A.L.; Corey, J.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.); Mcleod, K.W.; Pinder, J.E. (Savannah River Ecology Lab., Aiken, S.C. (USA)). pp 347-361 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975). See CONF-751105—.

Twenty-three representative sampling locations on and adjacent to the Savannah River Plant (SRP) site were selected to obtain information on plutonium movement in the food chain under southeastern US environmental conditions. Soil, a resuspendible fraction of the soil, honeysuckle (Lonicera japonica), and camphor weed (Heterotheca subaxillaris) were collected at each location. Grasshoppers and cotton rats (Sigmodon hispidus) were collected at some locations. The plutonium concentrations in soil at the selected locations ranged from 1.5 to 171fCi/g and alpha percentages of ^{238}Pu ranged from 2 to 66. The concentration of plutonium in the vegetation and on the leaves ranged from 0.17 to 76.1fCi/g and the alpha percentages of ^{238}Pu from 3 to 61. The concentration of plutonium in cotton rats and grasshoppers ranged from 0.07 to 3.58fCi/g and the alpha percentages of ^{238}Pu ranged from 22 to 80. The average ratio of plutonium concentration of vegetation to that of the surrounding soil was 10^{-1}; the corresponding ratio for cotton rats and soil was 10^{-2}. These ratios appear to be independent of the plutonium concentration in the soil. Deposition on the surfaces of leaves and stems was the principal mechanism of plutonium contamination of vegetation. Comparisons among the plutonium values of the vegetation, soil and resuspendible fraction suggest the use of a proposed resuspendible measurement technique as a monitoring method to indicate subtle changes in the plutonium concentration of the soil surface that are not detectable by routine soil sampling. Although the ^{238}Pu data in the various ecosystem components were not conclusive, they do support evidence presented in other studies that there is an apparent increase in the biological availability of ^{238}Pu relative to that of sup(239,240)Pu in the environment. The plutonium concentrations of all ecosystem components decreased as the distance from the reprocessing plants increased.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 11491, 11499, 12555, 12620, 13173

13083 Site planning as a means of fulfilling the principles of provision in environmental protection. Dreyhaupt, F.J. (Ministerium

fuer Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen, Duesseldorf (Germany, F.R.)). pp 10-19 of In Technology of environmental protection - state and future development. Essen, Germany, F.R.; Vulkan-Verlag (1977). (In German)

From Technology of environmental protection - state and future developments; Essen, Germany, F.R. (25 - 26 Nov 1976).

The importance of site planning for strongly emitting energy facilities (fossil power stations, nuclear power plants, refineries) and the site situation (Voerde, Brokdorf) in the FRG, in particular in Northrhine-Westphalia, are emphasized and protrayed. Some solutions are offered, as e.g. site programs on the level of Laender development planning, which would mean that a multitude of sites for certain purposes with be brought up for public discussion very early on.

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 11770

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11488, 11649, 11653, 12028, 13041, 13052

13084 **Method and device for determining residual oil and/or the oil content in water.** (to Essers (A.), Monschau (Germany, F.R.)). German(FRG) Patent 2,532,869/A/. 17 Feb 1977. 13p. (In German).

A method is described which allows the residual oil or the oil content contained in a water sample to be determined qualitatively and possibly also quantitatively by means of a fluorescence method in a relatively short time.

13085 **Mathematical prediction model for bacterial loads in running waters.** Rump, H.H. (Institut fuer Naturschutz, Umweltschutz, Oekologie und Stadthygiene, Darmstadt (Germany, F.R.)). *Gesund.-Ing.;* **98**: No. 1/2, 11-14(Jan 1977). (In German).

With the aid of statistical methods it is possible to arrange receiving bodies of water in groups of different water quality. In this context, the criterion variable bacterial count can be predicted by selected predictor variables within given probability limits in a model which only considers the spatial aspects. The quality of the model is tested with several methods.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 11753, 13067, 13068, 13069, 13070

13086 (BNWL—2117, pp 291-504) **Behavior of plutonium-238 solutions in the soil and hydrology system at Mound Laboratory.** Rodgers, D.R. 1976.

From Conference on actinide sediment reaction; Seattle, WA, USA (10 Feb 1976).

In Proceedings of an actinide-sediment reactions working meeting.

Because plutonium is a potentially hazardous material, extensive precautions have been exercised since Pu operations began at Mound Laboratory to carefully maintain strict control of the Pu and to prevent significant amounts from entering the environment. These precautions include elaborate facility and equipment design criteria, scientific expertise, experience, personnel training, management and operational control systems, and environmental monitoring. In spite of these precautions, in early 1974, core samples from area waterways collected and analyzed showed that ^{238}Pu concentrations in the sediment of certain waterways adjacent to the site were above the baseline levels expected (<0.0004 nCi/g). These ^{238}Pu deposits presented no immediate hazard to the general population in the area as indicated by the air and water concentrations which were well within accepted Radioactivity Concentration Guides (RCG) for ^{238}Pu. Data are presented from an investigation of the extent of the contamination, the source of Pu, how it was transported and deposited in waterways, and potential hazards of these deposits to the general public.

13087 (EPA—520/4-77-005, pp 127-138) **Comprehensive executive activities.** Aug 1977.

In Radiation protection activities, 1976.

Radiation protection activities related to the marine disposal of radioactive wastes are reviewed. Research programs on the biological effects of low levels of environmental radiation are summarized.

13088 **Plutonium and americium in Lake Michigan sediments.** Edgington, D.N.; Alberts, J.J.; Wahlgren, M.A.; Karttunen, J.O.; Reeve, C.A. (Argonne National Lab., Ill. (USA)). pp 493-514 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975).

See CONF-751105—.

The vertical distributions of sup(239,240)Pu, ^{238}Pu and ^{137}Cs have been measured in sediment cores taken from Lake Michigan. Sections from a limited number of cores have been analysed for ^{241}Am. In addition, grab samples from ten locations in the southern basin of the lake have been analysed for phase distribution of sup(239,240)Pu using a sequential extraction technique. The results indicate that the sup(239,240)Pu, ^{238}Pu and ^{137}Cs from weapons testing, and the ^{241}Am formed in situ are concentrated in the sediments. A comparison of the total deposition of sup(239,240)Pu and ^{137}Cs indicates that ^{137}Cs may be valuable as a monitor for sup(239,240)Pu deposition in the sediments. Values of the ^{238}Pu/sup(239,240)Pu ratio are in agreement with values reported in Lake Ontario sediments (and Lake Michigan plankton) and show little variation with depth. ^{241}Am data support the concept of in situ production with little preferential mobility after formation. Studies of sedimentary phase distributions show that sup(239,240)Pu is associated with hydrous oxide phases, which are chemically stable under the prevailing conditions in the lake sediments. Since Lake Michigan sediments remain aerobic, relatively little sup(239,240)Pu is available for chemical mobilization from the hydrous oxide or organic phases present in the sediments.

13089 (UCRL—80279) **Environmental radiological surveillance in perspective: the relative importance of environmental media as a function of effluent pathway and radionuclides.** Denham, D.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 32p. (CONF-770720—6). Dep. NTIS, PC A03/MF A01.

From 22. annual meeting of the Health Physics Society; Atlanta, GA, USA (3 Jul 1977).

Most published guidelines for environmental surveillance emphasize the collection and analysis of specific media (e.g. air, water, milk, direct radiation) without total regard for the potential dose impact of the radionuclides expected in or actually present in the effluent streams from nuclear facilities. To determine the relative importance of medium/nuclide combinations in environmental surveillance, the experience at major ERDA sites and at operating nuclear power plants was reviewed. Typical release rates for nuclide groupings (tritium, noble gases, radioiodine, mixed fission or activation products, and transuranics) in those effluent streams were followed through various environmental pathways. By using this scheme the environmental medium which is most prominent in the critical dose pathway to man was determined. It was also possible to determine points of short-or long-term contaminant accumulation. Following these calculations, each medium was ranked for a given nuclide/effluent pathway combination providing the relative importance of sampling specific environmental media with emphasis on the radiation dose to a critical population group. Finally, the results of these environmental pathway studies are presented in tabular form to provide ready reference for environmental surveillance program design or evaluation.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 13072

13090 **Study of the behaviour of transuranics and possible chemical homologues in Lake Michigan water and biota.** Wahlgren, M.A.; Alberts, J.J.; Nelson, D.M.; Orlandini, K.A. (Argonne National Lab., Ill. (USA)). pp 9-24 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975).

See CONF-751105—.

Concentration factors for Pu, Am and U in Lake Michigan biota are compared to those of a number of stable trace elements that have short residence times in Lake Michigan water. The relative order of uptake for these nuclides in Lake Michigan biota is Am>Pu much>U. Evidence is summarized which suggests that the predominant oxidation state of ^{239}, ^{240}Pu in Lake Michigan water is 4+. Concentrations of ^{239}, ^{240}Pu in net plankton, filterable particulate matter, sediment trap, and benthic floc samples indicate that sorption by biogenic detritus, and settling of this material, can account for the reduced concentration of ^{239}, ^{240}Pu observed in surface waters during summer stratification, but that deposition into the sediments is

primarily non-biological. Concentrations of ^{7}Be, ^{144}Ce and ^{137}Cs in sediment trap samples show the effect of spring convective mixing and demonstrate the resuspension of mineral-rich surficial sediments during the summer months. The effect on the concentration of dissolved plutonium in the water column, of varying degrees of resuspension of sedimentary floc, is described using a simple mass-action model. A radiochemical method for the determination of americium and uranium in Lake Michigan environmental samples is also presented.

13091 Determination of biological indicators for monitoring plutonium contamination of a coastal region. Fraizier, A.; Guary, J.C. (CEA Centre de La Hague, 50 - Cherbourg (France). Services de Production). pp 679-689 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976). (In French)

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975).

See CONF-751105—.

The accumulation of plutonium by 31 vegetal and animal marine species belonging to a large number of phyla was demonstrated in a reference coastal site. Fixation levels, ranging from 171.6 pCi/kg fresh weight for a lichen to 0.04 pCi/kg fresh weight for a fish, showed that the retention of the radionuclide by the organisms studied was related to their phylogenetic position. Biological indicators especially suitable for monitoring coastal plutonium radioactivity have been identified.

REGULATIONS

REFER ALSO TO CITATION(S) 12557

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 12553, 12631, 12641

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 11657, 11658, 11707

BIOMEDICAL SCIENCES, BASIC STUDIES

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 13138, 13141, 13143, 13151, 13152, 13159

13092 5-iodoacetamidofluorescein-labeled chloroplast coupling factor 1: conformational dynamics and labeling-site characterization. Hartig, P.R. (Univ. of California, Berkeley); Bertrand, N.J.; Sauer, K. *Biochemistry;* **16**: No. 19, 4275-4282(20 Sep 1977).

Physical and spectroscopic properties of 5-iodoacetamidofluorescein (5-IAF), a new sulfhydryl-specific fluorescent label, are described. Under certain conditions, 5-IAF labels the chloroplast phosphorylation coupling factor (CF) predominantly on the β subunit. Approximately 88% of the ATPase activity and over 60% of the ability of CF to reconstitute photophosphorylation are retained after labeling. Trypsin activation of the ATPase activity of 5-IAF-labeled CF dramatically alters the fluorescence properties at the labeling site, indicating its involvement in ATPase activation. Studies of the fluorescence emission spectra, fluorescence polarization, and potassium iodide quenching of 5-IAF and 5-IAF-labeled CF demonstrate that the labeling site is in a partially buried hydrophobic region which is partially accessible to potassium iodide quenching from the solvent phase and which restricts the motion of the fluorescent label. The fluorescence shows little change upon substrate binding. We conclude that the label is located in a cleft region remote from the enzyme active site. Variation of the reaction pH between 6.4 and 8.5 significantly alters the number of attached labels. ATP decreases the extent of labeling over the entire pH range studied. These labeling changes reflect substrate- and pH-induced conformational changes in CF. Certain interdependences observed in these conformational changes suggest that the transmembrane electrochemical gradient may directly induce conformational changes in CF leading to net ATP synthesis. The γ subunit plays a central role in the expression of these intersubunit conformational changes.

13093 Mouse sperm chromatin proteins: quantitative isolation and partial characterization. Balhorn, R.; Gledhill, B.L.; Wyrobek, A.J. *Biochemistry;* **16**: No. 18, 4074-4080(6 Sep 1977).

Conditions are described that permit the quantitative extraction of chromatin proteins from the epididymal sperm of the mouse. These proteins have been isolated free of contaminating tail proteins following removal of the tails with cetyltrimethylammonium bromide (CTAB). Without this treatment, numerous acid-soluble tail proteins coextract with the nuclear proteins isolated from partially purified heads. The proteins isolated in this manner do not require prior modification with iodoacetamide and show no evidence of proteolytic degradation. In acid-urea polyacrylamide gels, 99% of the sperm protein migrates as one electrophoretic band. Evidence is presented that suggests that this single band contains two protamine-like proteins.

13094 DNA synthesis and its regulation. Volume 3. Goulian, M.; Hanawalt, P. (eds.). Contract EX-76-C-23-3155. Menlo Park, CA; W.A. Benjamin, Inc. (1975). 892p. (CONF-750391—).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

Separate abstracts were prepared for the 56 papers presented at the conference. A subject index is included. (HLW)

13095 DNA polymerase III from Bacillus subtilis and the mechanism of arylhdrazinopyrimidine inhibition. Cozzarelli, N.R.; Low, R.L.; Rashbaum, S.A.; Peebles, C.L. (Univ. of Chicago). Contract EX-76-C-23-3155. pp 14-37 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Bacillus subtilis DNA polymerase III has been purified about 4500 fold. When subjected to disc gel electrophoresis, the most purified fraction exhibits a single major protein band which migrates with the same mobility as polymerase activity. Polyacrylamide gel electrophoresis of the polymerase under denaturing conditions yields a single, 165,000 dalton band. The hydrodynamic properties of the enzyme are ionic strength dependent. The average values from determinations in high and low salt are 7.6 S for the sedimentation coefficient and 52 Å for the Stokes radius. These two parameters indicate a molecular weight for the native enzyme of 160,000 daltons. Therefore, the enzyme appears to contain a single, long, polypeptide chain. DNA polymerase III also catalyzes pyrophosphate exchange into deoxyribonucleoside triphosphates, pyrophosphorolysis of DNA, hydrolysis of DNA, and hydrolysis of RNA. The intrinsic exonuclease of the polymerase attacks single-stranded DNA from the 3′-terminus yielding 5′-mononucleotides. All five enzymatic activities of DNA polymerase III are inhibited by arylhydrazinopyrimidines. These drugs inhibit by forming a long-lived ternary complex with the enzyme and the DNA substrate. The drugs bind to the template in a base-specific manner such that a uracil containing drug pairs with cytosine and an isocytosine analogue pairs with thymine.

13096 In vitro DNA synthesis on primed covalently closed double-stranded templates. I. Studies with Escherichia coli DNA polymerase I. Liu, L.F.; Wang, J.C. (Univ. of California, Berkeley). Contract EX-76-C-23-3155. pp 38-63 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

In order to study DNA synthesis on intact double-stranded template molecules, methods have been developed to prepare negative superhelical DNA samples with short DNA or RNA fragments paired to the strands of the covalently closed DNA. With Escherichia coli DNA polymerase I, provided that the primer fragments possess 3′ hydroxyl termini, extension of the primer fragments can occur, yielding covalently closed circular molecules with enlarged loops or "eyes." Several other competing processes have also been observed. Template switching by the enzyme may occur; extension of the primer fragment and copying of the strand the primer is annealed to may be followed by the copying of the other strand. It is also found that endonucleolytic cleavage of the strands of the covalently closed DNA may occur. Several experiments indicate that the endonucleolytic activity is an activity of the polymerase itself. Efficient endonucleolytic scission is observed only when the primer fragments have 3′-hydroxyl end groups and that DNA synthesis is occurring. Antibodies specific for polymerase I also block the endonucleolytic activity. Furthermore, the requirements for the endonucleolytic activity are similar to the requirements for polymerizing activity.

13097 Hela cell DNA polymerases: properties and possible functions. Weissbach, A.; Spadari, S.; Knopf, K.W. (Roche Inst. of Molecular Biology, Nutley, NJ). Contract EX-76-C-23-3155. pp 64-

82 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Four distinct DNA polymerases have been identified in vertebrate and mammalian cells. These enzymes, named polymerase α, β, γ, or mitochondrial, have been partially purified from HeLa cells and examined for properties related to their possible role in DNA replication. The HeLa polymerases are found not to be related to one another and to show unique responses to natural RNA primers, histones, and certain DNA binding proteins. These results combined with in vivo studies of synchronized cells indicate that DNA polymerase α is associated with DNA replication. The functions of DNA polymerases β and γ remain unknown.

13098 Assay and partial purification of the DNA untwisting activity from rat liver. Champoux, J.J.; Durnford, J.M. (Univ. of Washington, Seattle). Contract EX-76-C-23-3155. pp 83-93 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A DNA filter binding assay and a fluorometric assay have been developed for the DNA untwisting enzyme. Using these assays, the activity has been partially purified from rat liver nuclei.

13099 Isolation and properties of a nicking-closing protein from mammalian nuclei. Vosberg, H.P.; Vinograd, J. (California Inst. of Tech., Pasadena). Contract EX-76-C-23-3155. pp 94-121 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

An enzyme able to release superhelical turns in closed circular DNA, called relaxation protein, has been isolated and partially purified from the nuclei of mouse L cells. It is predominantly located in the nuclei, tightly associated with DNA and is apparently a major constituent among the nuclear non-histone proteins. It relaxes, without need for a cofactor, negatively and positively supercoiled DNA. The optimal conditions at 37° are 0.2 M NaCl and 10 mM potassium phosphate or Tris-HCl buffer, pH 7.0. Relaxation protein acts enzymatically, one enzyme molecule relaxes on the average at least 8 PM2 DNA I molecules in two hours. The reaction is roughly first order during the first 30 min at 37°. The relaxation activity is measured by a fluorometric assay which uses the fluorescence enhancement of ethidium bromide bound to DNA and the fact that the binding affinity of the dye to closed circular DNA depends on the superhelix density of the DNA. The biological function of the enzyme is not yet known, but its in vitro reaction with superhelical DNA suggests a role as a nicking-closing device active on replicating DNA ahead of the replication fork. Alternatively any nuclear process which is either accompanied by or requires a change in the duplex winding number of the DNA may be affected by this enzyme.

13100 RNA molecules attached to DNA in isolated bacterial nucleoids: their possible role in stabilizing the condensed chromosome. Hecht, R.M.; Pettijohn, D. (Univ. of Colorado Medical Center, Denver). Contract EX-76-C-23-3155. pp 122-137 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The studies described here inveestigated the mode of binding of RNA molecules to the isolated nucleoid of Escherichia coli. Membrane free nucleoids with ^{3}H-labeled RNA components were reacted briefly with RNA'ase A. The average molecular weight of the attached nascent RNA chains was reduced to less than one fourth the initial size; however, very little of the RNA was released from the nucleoid. Even when the state of condensation of the nucleoid was further relaxed by intercalation of ethidium bromide, the RNA fragments remained bound to the nucleoid. The results suggest that many of the nascent RNA chains are found to the DNA of the nucleoid at multiple sites. When the DNA of the nucleoid was completely unfolded, fragmented and deproteinized, 60 to 100 nascent RNA chains per nucleoid equivalent of DNA remained bound to the DNA. These RNA chains were released from the DNA by heating at 96°C. Several properties of the bound RNA and its mode of attachment to the DNA are consistent with the idea that these RNA molecules are those involved in stabilizing the condensed state of the DNA in the folded chromosome; however, the data do not prove this interpretation.

13101 Viscometric analysis of conformational transitions in the Escherichia coli chromosome. Drlica, K.; Worcel, A. (Princeton Univ., NJ). Contract EX-76-C-23-3155. pp 138-158 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The effects of physical, chemical and enzymatic treatments on purified folded chromosomes from Escherichia coli were monitored by viscometry. The following chromosome conformation states were clearly distinguishable: folded, supercoiled, ethidium bromide relaxed, partially unfolded by ribonuclease, and completely unfolded chromosomes. The results confirm earlier sedimentation studies indicating that chromosomal DNA is supercoiled, and in addition, they show that supercoiling is lost after treatment with ribonuclease. Extensive incubation with pancreatic ribonuclease A unfolded the chromosomes only partially; complete unfolding required incubation at mild temperatures (60 to 70°C). Solutions of chromosomes partially unfolded by ribonuclease became even more viscous when protease VI was included in the incubation mixture, suggesting that proteins are involved in maintaining the chromosome structure.

13102 Properties of membrane-associated folded chromosomes of Escherichia coli during the DNA replication cycle. Ryder, O.A.; Kavenoff, R.; Smith, D.W. (Univ. of California, San Diego, La Jolla). Contract EX-76-C-23-3155. pp 159-186 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Folded chromosomes remain associated with the cell envelope during their replication and after completion of residual synthesis under conditions which prohibit reinitiation of new rounds of chromosome replication. Membrane-associated folded chromosomes become more rapidly sedimenting as replication proceeds in the absence of reinitiation. Sedimentation analysis of folded chromosomes prepared from amino acid-starved cultures or from a dnaC initiation mutant suggests that a unique structure is associated with completion or near completion of rounds of chromosome replication. Before reinitiation of chromosome replication occurs after restoring required amino acids to amino acid-starved cells or after lowering the temperature in a thermosensitive dnaC mutant, sedimentation velocities of the membrane-associated folded chromosomes decrease substantially. The decrease in sedimentation velocity does not depend on renewed DNA synthesis, but does require the activity of at least the dnaC product. Electron microscopy of membrane-associated folded chromosomes from exponentially growing and amino acid-starved E. coli 15 TAU-bar, utilizing aqueous spreading techniques, has revealed a spectrum of structures ranging from condensed structures with no DNA fibers visible to extended structures with DNA fibers. The structures with free DNA most probably arise from the condensed structures, possibly during the spreading procedure.

13103 Membrane-DNA complex in Bacillus subtilis. Imada, S.; Carroll, L.E.; Sueoka, N. (Univ. of Colorado, Boulder). Contract EX-76-C-23-3155. pp 187-200 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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A DNA-membrane complex (M2) from Bacillus subtilis has previously been separated from the major membrane fraction (M1) by a CsCl-sucrose double gradient centrifugation. The M2 DNA has been shown to be enriched in genetic markers which map close to the replication origin and terminus. The complex has also been shown to possess a characteristic set of proteins. The complex originated from the membrane attached folded chromosome. The complex (M2) is disrupted by detergents such as sarkosyl, Brij 58, Tween 80 and sodium deoxycholate, while RNase and phospholipase A do not disrupt the complex. Iodination of intact cells with ^{125}I shows a preferential labeling of the complex suggesting that at least part of the complex is exposed on the external membrane surface. Possible models of the DNA-membrane complex are proposed.

13104 Unit chromosomal fiber: evidence for its universal nature. Griffith, J.D. (Stanford Univ. School of Medicine, CA). Contract EX-76-C-23-3155. pp 201-209 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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DNA in eukaryotic cells is condensed into unit fibers 110 A in diameter. Several parameters of the fibers: a 7-fold contraction of the enclosed DNA duplex, a 200 base pair substructure, and a partial melting have been measured. By gentle disruption of prokaryotic cells their DNA is seen also to exist in apparently the same unit fiber.

The fine structure of the eukaryotic chromosome is being dissected in many laboratories. It has been shown that in the higher cell DNA exists in an elemental unit fiber roughly 110 A in diameter (1). The unit fiber structure confers several unique properties on the DNA. The duplex is foreshortened 7-fold as a chain of 200 base pair beads and is melted by about 10% (2). We see evidence of this melting as supercoiling. When such condensed DNA becomes covalently closed to form a duplex circle, it will appear topologically relaxed as long as it is maintained in that form. If the factors generating the condensation and partial melting are disrupted, the DNA will renature and the strain of the melting will spread uniformly over the DNA and appear as a topological twisting or supercoiling of the circle. In higher cells the formation of the unit fiber is believed to be dependent on the presence of histone proteins present in an equal mass with the DNA. This report will suggest that a similar condensation is present in the DNA of prokaryotic cells where the histones are absent.

13105 Multienzyme systems in the replication of 0X174 and G4 DNAs. Bouche, J.P.; Schekman, R.; Weiner, J.; Zechel, K.; Kornberg, A. (Stanford Univ., CA). Contract EX-76-C-23-3155. pp 210-226 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Eight purified proteins are required for the conversion of OX174 from single-stranded circular DNA (SS) to RF II (a duplex with a small gap). These are: products of genes dnaB, dnaC, dnaE (DNA polymerase III) and dnaG, the DNA-unwinding protein, copolymerase III, protein i and protein n. In addition to the DNA-unwinding protein, protein n may play a structural role as judged by a six-fold condensation of the viral DNA into a beaded structure visualized by electron microscopy. The conversion can be separated into a state of initiation and a stage of DNA synthesis. Addition of the ribonucleoside triphosphates during the first stage, but not during the second stage, stimulates DNA synthesis, suggesting the synthesis of a primer RNA. Evidence for the role of dnaG protein as an RNA polymerase in the synthesis of such a primer has been obtained with the DNA of phage G4 (a OX-like particle) as template. Conversion of G4 DNA to RF II requires only dnaG protein, the DNA unwinding protein, DNA polymerase III and copolymerase III. The dnaG protein transcribes the complex of G4 SS plus the DNA-unwinding protein to yield RNA fragments about 20 nucleotides in length. After replication, one of these fragments is covalently linked to the synthetic complementary stand at or near a unique initiation 5'-end of the DNA.

13106 In vitro synthesis of DNA. Wickner, S. (National Cancer Inst., Bethesda, MD); Hurwitz, J. Contract EX-76-C-23-3155. pp 227-238 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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phi chi 174 DNA-dependent DNA synthesis is catalyzed in vitro by the combination of 10 purified protein preparations, ATP, 4 dNTPs and Mg^{2+}. The reaction has been resolved into 2 steps; the phi chi 174 DNA-protein complex formed in the first step (dependent upon ATP, phi chi 174 DNA and 6 protein components) has been isolated by gel filtration and supports DNA synthesis following the addition of dNTPs and the remaining protein components. Partial reactions involving proteins required in the first step include: ribonucleoside triphosphatase activity of dnaB gene product which is stimulated by single-stranded DNA, ATP-dependent complex formation by dnaB and dnaC(D) gene products, and phi chi 174 DNA-dependent ATPase activity associated with DNA replication factor Y.

13107 In vitro synthesis of bacteriophage T7 DNA. Masker, W.E.; Hinkle, D.C.; Mark, D.; Modrich, P.A.; Richardson, C.C. (Harvard Medical School, Boston). Contract EX-76-C-23-3155. pp 239-240 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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The virulent bacteriophage T7 contains a 26 x 10^6 dalton linear duplex DNA molecule with coding capacity for approximately 30 proteins. Genetic analysis of phage T7 has shown that the products of genes 1, 2, 3, 4, 5, and 6 are required for viral DNA synthesis in vivo, and several of these products have been purified and characterized. Recently cell-free systems that support replication of T7 DNA in vitro have been developed. Incorporation of deoxyribonucleotides into T7 DNA in vitro is dependent on the products of phage genes 4 and 5, but not those of genes 2, 3, or 6. This requirement has provided a complementation assay for the purification of the product of genes 4 and 5. In addition in vivo T7 DNA replication is completely blocked in Escherichia coli tsnC mutants.

13108 Reconstruction of the T4 bacteriophage DNA replication apparatus from purified components. Alberts, B.; Morris, C.F.; Mace, D.; Sinha, N.; Bittner, M.; Moran, L. (Princeton Univ., NJ). Contract EX-76-C-23-3155. pp 241-269 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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The protein products of T4 genes 41, 43 (T7 DNA polymerase), 45, 44, and 62 have been purified to near homogeneity, using individual "complementation assays" which measure their ability to stimulate DNA synthesis in an appropriate mutant-infected crude lysate. The gene 44 and 62 proteins are copurified as a tight complex which displays DNA-dependent ATPase activity. In a reaction requiring 45 protein, this complex speeds up in vitro polymerization by T4 DNA polymerase on primed single-stranded templates to near in vivo rates. Further addition of gene 32 and gene 41 proteins allows two additional reactions: extensive synthesis by strand-displacement on double-stranded DNA templates (as expected for synthesis on the leading side of a replication fork), and de novo DNA chain initiation on single-stranded DNA templates, dependent on the presence or ribo C, G, and U nucleoside triphosphates (as expected for RNA-priming of Okazaki pieces on the lagging side of the replication fork). With the complete system operating on circular fd DNA templates, the products visualized in the electron microscope resemble classical rolling circles, with discontinuous DNA synthesis clearly evident on the long, unbranched double-stranded tails.

13109 Stimulation of DNA replication in vitro by Escherichia coli periplasmic factors. Smith, D.W.; Kemper, C.; Zyskind, J.W. (Univ. of California, San Diego, La Jolla). Contract EX-76-C-23-3155. pp 270-295 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Osmotic shock fluid obtained from E. coli contains macromolecular factors which stimulate the ATP-dependent semiconservative mode of in vitro DNA synthesis. Evidence is presented that these factors come from E. coli periplasmic space. This stimulation is observed when assayed using either toluenized cells or lysed agar-embedded lysozyme spheroplasts as the in vitro DNA synthesis system. Shock fluid obtained from a given E. coli dna mutant does not stimulate in vitro DNA synthesis by that mutant. However, in some cases, shock fluid from one class of dna mutants does stimulate ATP-dependent in vitro DNA synthesis by another class of dna mutants, in a thermosensitive reaction. Gently prepared cell extracts also stimulate ATP-dependent in vitro DNA synthesis, whereas cell extracts prepared by more severe procedures inhibit this in vitro synthesis. The stimulating activity in shock fluid is nondialyzable, partially RNase sensitive, and heat sensitive. Several factors may be present in the osmotic shock fluid, including products of E. coli dna genes.

13110 Studies on the in vitro replication of the Escherichia coli chromosome. Kornberg, T. (Princeton Univ., NJ). Contract EX-76-C-23-3155. pp 296-303 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Evidence obtained from in vivo studies of bacteriophage and bacterial chromosome replication indicates that DNA synthesis proceeds discontinuously. We have recently shown that the E. coli replication apparatus can be reconstructed in vitro and that this in vitro replication of the E. coli chromosome also proceeds by a discontinuous mechanism. In this system, the newly made DNA fragments, "Okazaki pieces," can be joined together; sealing of these replicative intermediates to high molecular weight DNA requires both DNA polymerase I and DNA ligase, in agreement with other in vivo and "quasi in vitro" observations. We have further characterized the synthesis and joining of in vitro synthesized Okazaki pieces, and find that the sealing of these replication intermediates can be described by a simple, first order mechanism.

13111 Evidence that both growing DNA chains at a replication fork are synthesized discontinuously. Sternglanz, R.; Wang, H.F.; Donegan, J.J. (State Univ. of New York, Stony Brook). Contract EX-76-C-23-3155. pp 309-321 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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E. coli and B. subtilis have been labeled with short pulses of ^{3}H-thymidine and the labeled DNA examined by sedimentation in alkaline sucrose. In both systems, the great majority of the DNA labeled by a short pulse is found in the form of small DNA chains of 10S, the so-called Okazaki pieces. The B. subtilis nascent DNA fragments hybridize with equal efficiency to the separated strands of B. subtilis. The results suggest that both growing DNA chains at a given replication fork are synthesized discontinuously in the case of both E. coli and B. subtilis. We have found that the method used to terminate the pulse determines the fraction of labeled DNA found as short DNA fragments. Previous reports of discontinuous DNA synthesis on only one growing DNA chain and continuous synthesis on the other DNA chain are probably due to preferential joining of Okazaki pieces after termination of the pulse, on the DNA chain growing in the overall 5′ → 3′ direction.

13112 DNA synthesis in human lymphocytes. Tseng, B.Y.; Oertel, W.; Fox, R.M.; Goulian, M. (Univ. of California, San Diego, La Jolla). Contract EX-76-C-23-3155. pp 322-333 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Three in vitro systems for the study of DNA synthesis in a human lymphocyte cell line are described. DEAE-Dextran treated cells take up nucleotides but in many other features resemble intact cells, whereas the two other systems employ broken cells. The characteristics of synthesis and the nature of the products are described. In all three systems nascent DNA sediments in a 4S range, which by polyacrylamide gel analysis is approximately 120 nucleotides in length. The three systems have been used to examine the mechanism of DNA synthesis in the human cell line. Nascent DNA is the precursor to high molecular weight DNA and extends from 100 up to several hundred nucleotides before attaching to the growing daughter strand. The technique of nearest neighbor transfer of incorporated ^{32}P-labeled deoxynucleotides provides evidence for RNA in the nascent DNA. There is one RNA-DNA junction per nascent chain but the RNA sequence is not specific. Removal of the RNA is correlated with the ability to synthesize DNA. The evidence suggests that the RNA serves a primer function for the synthesis of nascent DNA.

13113 Evidence for RNA linked to nascent DNA in eukaryotic organisms. Waqar, M.A.; Minkoff, R.; Tsai, A.; Huberman, J.A. (Massachusetts Inst. of Tech., Cambridge). Contract EX-76-C-23-3155. pp 334-357 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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In this paper we report the results of our efforts to detect RNA linked to nascent DNA in two kinds of eukaryotic organisms: the slime mold Physarum polycephalum and cultured mammalian cells (in most experiments, CHO cells). We have tried to detect such linkages because of the possibility that RNA may serve as a primer for the synthesis of DNA. In Physarum nascent DNA chains appear to have a density greater than that of single-stranded, mature Physarum DNA. If the nascent DNA chains are treated with KOH or RNase, then less density difference is found, suggesting that the density difference is due to RNA attached to the nascent DNA. When Physarum DNA is labeled for 2 min or 5 min with α-^{32}P-deoxyribonucleoside triphosphates which have been injected into the plasmodium, then alkaline hydrolysis of the labeled DNA reveals the presence of a small proportion of ribonucleotides on the 5′ side of the labeled deoxyribonucleotides, consistent with the covalent attachment of a stretch of RNA to the 5′ end of the nascent DNA chain. Although nascent DNA in mammalian cells does not differ in density from mature DNA, alkaline hydrolysis of mammalian DNA labeled in cell-free lysates with α-^{32}P-deoxyribonucleoside triphosphates does reveal occasional RNA-DNA junctions within the nascent DNA. Thus, although evidence for covalent linkage to RNA to nascent DNA is much harder to find in mammalian cells than in Physarum, it is likely that such junctions are present in mammalian DNA.

13114 Initiator RNA in discontinuous synthesis of polyoma DNA. Reichard, P. (Karolinski Inst., Stockholm). Contract EX-76-C-23-3155. pp 357-360 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Our data suggest that the synthesis of Okazaki fragments of polyoma DNA is initiated by a new class of low molecular weight RNA for which we propose the name initiator RNA. We find no evidence for a specific base sequence but the molecules show a remarkable homogeneity in size, corresponding to that of a decanucleotide. We propose that the size of iRNA may play a role as a signal for the switch from RNA to DNA synthesis. This raises the further more speculative possibility that the size of complete Okazaki fragments may determine new points of initiation of iRNA and thereby of new Okazaki fragments. Thus chain size, rather than base sequence, may play a role as a "signal" during discontinuous DNA synthesis. There is good reason to believe that the elongation of polyoma DNA is catalyzed by the replication machinery of the host cell and that the results obtained with a viral DNA thus may be of a more general significance for our understanding of how mammalian DNA is replicated.

13115 Discontinuous SV40 DNA synthesis and the detection of gap circle intermediates. Laipis, P.J.; Sen, A.; Levine, A.J.; Mulder, C. (Princeton Univ., NJ). Contract EX-76-C-23-3155. pp 361-369 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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When SV40 DNA synthesis is inhibited in infected cells by the drug hydroxyurea, replicative intermediates accumulate, with single-stranded gaps separating short, 4S, Okazaki-like fragments of DNA from the longer progeny strands. A similar gapped structure exists in SV40 replicative intermediates isolated after a brief pulse-label with (^{3}H)-thymidine. In addition to the gapped replicative intermediate molecules, a class of 16S terminating intermediate molecules has been shown to exist in both drug inhibited, infected cells and normal infected cells. These molecules contain a 3′-hydroxy, 5′-phosphate bounded gap at the terminus of DNA replication. Our results suggest that separation of interlocked daughter SV40 molecules can occur before DNA strand elongation has finished.

13116 Structure and replication of replicative forms of the 0X-related bacteriophage G4. Ray, D.S.; Dueber, J. (Univ. of California, Los Angeles). Contract EX-76-C-23-3155. pp 370-385 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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The DNA of the OX174-related bacteriophage G4 is clearly distinguished from that of OX174 by alkaline equilibrium centrifugation. G4 viral DNA bands at a density of 1.753 g/cc, while OX174 DNA bands at 1.765 g/cc. Similarly, the complementary strand of G4 replicative form bands at 1.767 g/cc, while that of OX174 bands at 1.756 g/cc. Both the viral and the complementary strand of G4 replicative forms are synthesized early in the infectious process. However, only the viral strand is replicated later in infection. Chloramphenicol at 30 μg/ml prevents this transition to an asymmetric mode of replication. Replication of G4 replicative form DNA is inhibited in E. coli rep cells and the parental replicative form accumulates in an open circular form having a closed circular complementary strand and a unit-length linear viral strand. The single discontinuity in the viral strand is located at 50% of the genome's length from G4's single Eco RI site. G4 open circular replicative DNA formed during single strand synthesis also has a unique discontinuity at 50% of the genome's length from the Eco RI site. We infer that nicking of G4 parental replicative form DNA prior to its replication occurs at the origin of the viral strand and that the viral strand origin is at the same site for both replicative form replication and single strand synthesis.

13117 Replication of 0X174 in Escherichia coli: structure of the replicating intermediate and the effect of mutations in the host lig and rep genes. Denhardt, D.T.; Eisenberg, S.; Harbers, B.; Lane, H.E.D.; McFadden, G. (McGill Univ., Montreal). Contract EX-76-C-23-3155. pp 398-422 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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Evidence is presented that the viral and complementary strands of phiX174 are synthesized by different processes in E. coli. The viral strand is synthesized on a double-stranded replicative form (RF) template by a continuous process starting in a specific region of the genome. A single gap, with an average size of 13 to 15 nucleotides, separates the 5′ end of the completed viral strand from the 3′ end in the nascent RF molecule containing the newly synthesized viral strand. Although the gap is located in a specific region of the genome, the gene A region, the complexity of the pyrimidine tracts characteristic of it indicates that the gap does not comprise a unique 15-nucleotide sequence. In contrast, the complementary strand is synthesized in a discontinuous fashion on a single-stranded DNA template. The gaps separating the nascent fragments can be found in many regions of the genome. However, the base composition and the distribution of radioactivity among the pyrimidine tracts suggest that these gaps in the complementary strand are not randomly

located. Polynucleotide ligase is required in vivo to join together the nascent complementary strand fragments when the gaps are filled in. The E. coli rep gene product, like the gene A product of phiX, is required for RF replication but not for synthesis of the complementary strand during parental RF formation; its function is unknown and although not essential for E. coli DNA replication its absence impairs the functioning of the cells replication forks.

13118 Bacteriophage M13 replication in E. coli dnaB strains. Bowes, J.M. (Univ. of California, Davis). Contract EX-76-C-23-3155. pp 423-444 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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By means of a single step growth procedure it was shown that all the dnaB strains tested (dnaB-70, -107, -279, -43, -6, -8,454, and -313) except dnaB-266 (see below) produced 10-100 phages per cell after infection at the restrictive temperature. Using this procedure it was possible to show that (i) lambda phage production (which has been shown previously to require the host cell dnaB function) still specifically required the dnaB function and (ii) the production of plaque forming units of M13 specifically required the dnaA, dnaC(D), dnaE and dnaG gene products. After infection of dnaB mutants at 42 C with M13 there was a marked stimulation of DNA synthesis as measured by incorporation of 3H-thymidine. All three major forms of phage specific DNA (RFI, RFII, and SS-DNA) as well as 3H-thymidine labeled phage were made in amounts approximating the amounts made in parallel infections of dnaB$^+$ transductants or revertants at the non-permissive temperature. One dnaB mutant (dnaB-266) was found not to produce M13 at restrictive temperature. However, no phage were produced at 42°C in a 42°C resistant transductant of dnaB-266 either. In both these strains, RF replication continued in the functional absence of dnaB and the defect in phage production seems to be due to some as yet undefined defect in SS-DNA synthesis which is present in both strains. The results presented in this paper, in contrast to previous reports, clearly establish that M13 does not require the dnaB function for progency RF replication and in fact no step in M13 replication specifically requires a functional dnaB product.

13119 Replication of mycoplasmaviruses. Maniloff, J.; Das, J. (Univ. of Rochester, NY). Contract EX-76-C-23-3155. pp 445-456 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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The MVL51 virion, a mycoplasmavirus with single stranded circular DNA, has been found to have four protein species. Two of these are found in the SSII replicative intermediate. Antibiotic studies indicate a coupling between penetration and DNA replication. These data are discussed, together with previous reports, to describe the molecular details of MVL51 replication. Host modification and restriction of an enveloped mycoplasmavirus have also been observed.

13120 Structural analysis of intercellular λ DNA. Valenzuela, M.S.; Inman, R.B. (Univ. of Wisconsin, Madison). Contract EX-76-C-23-3155. pp 452-459 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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In a study of late rounds of lambda cIIcIII replication about 0.3 percent of all circular types also involved junctions. Of twelve molecules exhibiting junctions, four were of the monomeric type while eight had junctions between two circles, where one circle of each pair was monomeric and the other either monomeric, dimeric or trimeric length. Partial denaturation mapping showed that in every case so far examined (26 molecules), junctions occur at homologous positions on each partner. However, they can occur at different positions from molecule to molecule. Junctions often exhibit single stranded fine structure. Out of 26 junctions, 14 were judged to have this structure while the rest were either not well resolved or ambiguous in this respect. Denaturation mapping shows that all molecules exhibit matching denatured sites in trans on either side of the junction. The DNA polarities can therefore be deduced. When this structure is redrawn so that the base sequences are congruent (denatured sites in cis) the resulting structure appears to involve a cross-strand exchange.

13121 Replication of mtDNA in Tetrahymena. Borst, P., Goldbach, R.W.; Arnberg, A.C.; Van Bruggen, E.F.J. (Univ. of Amsterdam). Contract EX-76-C-23-3155. pp 586-601 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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The mtDNA of Tetrahymena pyriformis, strain ST, is a linear duplex with a molecular weight of 3 x 10^7 and a unique gene sequence. Electron microscopy of replicating forms of this DNA, identified by pulse-labelling, shows these to be enriched in branched DNA molecules, all linear and of the same end to end length as unbranched mtDNA. The major type of branched DNA was a duplex with an internal "eye" of variable size; "eyes" were largely duplex but often contained short single-stranded sections in one or both forks. The data fit a replication model in which DNA synthesis starts near the middle and proceeds bidirectionally to the ends via intermediates with a largely duplex character. This replication mode should yield linear DNA with one 3'-single-stranded end, as pointed out by Watson. By electron microscopy of denatured mtDNA we have found two structures that could be involved in converting this single-stranded end into a duplex: strain ST mtDNA contains a long (1.3 μm), imperfect terminal duplication-inversion; strain GL mtDNA (which is very different from strain ST mtDNA) contains a sub-terminal duplication-inversion and a long (5 μm) palindrome on one end. Possible models for synthesizing the ends of linear DNA molecules are discussed.

13122 Regulation of the initiation of DNA replication in E. coli isolation of I-RNA and the control of I-RNA synthesis. Messer, W.; Dankwarth, L.; Tippe-Schindler, R.; Womack, J.E.; Zahn, G. (Max-Planck-Institut fuer Molekulare Genetik, Berlin). Contract EX-76-C-23-3155. pp 602-617 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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An RNA species required for the initiation of DNA replication (I-RNA)* was isolated as a copolymer of RNA covalently bound to high molecular weight DNA. The dnaC product is not required for the synthesis of I-RNA, but for its function as a primer. I-RNA synthesis is negatively controlled with the dnaA product being involved in this regulation. This suggests the existence of an I-RNA operon.

13123 Specific labelling of initiation RNA in E. coli. Womack, J.E.; Messer, W. (Max-Planck-Institut fuer Molekulare Genetik, Berlin). Contract EX-76-C-23-3155. pp 618-623 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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We have constructed a strain which allows us to independently label RNA and DNA, although RNA is labelled at a reduced rate. The reduction in the rate of labelling or RNA using ^{3}HUR precludes using this strain for rapid pulse-chase experiments; however, the labelling rates under special conditions allow us to label the I-RNA piece and isolate it while it is bound to relatively unlabelled DNA. This greatly facilitates the physical studies on this important piece of RNA.

13124 Triton X-100 dependent in vitro DNA synthesis in an E. coli dnaC mutant. Hanna, M.H.; Soucek, L.S.; Carl, P.L. (Univ. of Illinois, Urbana). Contract EX-76-C-23-3155. pp 640-649 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

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See CONF-750391—.

When an E. coli dnaC mutant is returned from nonpermissive to permissive conditions, DNA synthesis reinitiates in vivo but not in a toluene-treated in vitro system. However, Triton X-100 added to the toluene-treated cells stimulates DNA synthesis more than 15 fold. This DNA synthesis is ATP-dependent, semiconservative, and resistant to chloramphenicol or rifampin added in vitro, but sensitive to chloramphenicol added in vivo. In vitro reinitiation does not appear to require the dnaC protein.

13125 Role of semiconservative DNA replication in bacterial cell development. Leighton, T. (Univ. of California, Berkeley); Khachatourians, G.; Brown, N. Contract EX-76-C-23-3155. pp 677-687 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Bacillus subtilis sporulation is initiated when vegetative bacteria cease exponential growth. Chemical and radioisotopic measurements of DNA synthesis suggest that during the first two hours of sporulation, there is a postexponential doubling of cellular DNA content. During this same time period there is a substantial increase in cell mass. Microscopic and electronic particle size observations

indicate that the termination of DNA synthesis is followed by a conventional cell division and a concomitant internal asymmetric septation of mother cell and forespore chromosomes. The observed DNA synthesis is evidently semi-conservative as it is totally inhibited by the DNA polymerase III directed drug, 6-(p-hydroxyphenylazo)-uracil (HP-Ura). Addition of 50 μM HP-Ura to cultures of wild type B. subtilis causes an inhibition of sporulation during the first two hours (t0-t2) of the developmental process. HP-Ura addition has no effect on sporulation when added after t2.5. Similarly, 50 μM HP-Ura addition, at any time, to an isogenic strain of B. subtilis containing a single site HP-Ura resistant DNA polymerase III mutation has no effect on the sporulation sequence. From experiments where HP-Ura is added at various times during the t0-t2 increment it is apparent that the post-exponential cell division is coupled to semi-conservative DNA replication.

13126 Effect of an arlazopyrimidine on DNA synthesis in toluene-treated Salmonella typhimurium. Van Beveren, C.P.; Wright, A. (Tufts Univ. School of Medicine, Boston). Contract EX-76-C-23-3155. pp 688-694 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

We have examined DNA synthesis in toluene-treated cells of Salmonella typhimurium. DNA synthesis in cells deficient in DNA polymerase I requires the four deoxynucleoside triphosphates and ATP, and is sensitive to sulfhydryl reagents and nalidixic acid. It is also sensitive to 6-(p-hydroxyphenylazo)-uracil. This is the first demonstration that an arylazopyrimidine can inhibit DNA synthesis in a Gram-negative aerobe.

13127 Inhibition of DNA strand elongation by cycloheximide in Physarum polycephalum. Evans, H.H.; Evans, T.E.; Brewer, E.N. (Case Western Reserve Univ., Cleveland). Contract EX-76-C-23-3155. pp 713-716 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The mechanism of the inhibition of nuclear DNA replication by cycloheximide in Physarum polycephalum has been investigated by means of alkaline sucrose density gradient centrifugation techniques. The results suggest that the rapid decrease in the incorporation of [^{3}H]thymidine into DNA after exposure to cycloheximide is caused by an inhibition of the elongation of progeny strands. No effect was detected on either the initiation of the synthesis of DNA replication units or on the ligation of DNA fragments produced by ionizing radiation. It has been concluded that cycloheximide treatment inhibits the elongation of progeny strands within replication units, presumably by inhibiting the synthesis of short-lived proteins necessary for this process.

13128 Studies of DNA synthesis in permeabilized mouse L cells. Berger, N.A.; Johnson, E.S. (Washington Univ. Medical Center, St. Louis). Contract EX-76-C-23-3155. pp 719-729 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Mouse L cells, maintained in continuous suspension culture have been rendered permeable to deoxynucleoside phosphates by treating for 15 minutes at 4°C with a buffer containing .01M Tris-HCl pH 7.8, 0.25M Sucrose, 4mM Mg Cl_2, lmM EDTA and 30mM 2 mercaptoethanol. These cells use ^{14}C-UTP to synthesize RNA and ^{3}H-TTP to synthesize DNA. Subcellular distribution studies revealed that 98 percent of the DNA synthesized in these permeabilized cells was located in the nucleus. Cesium chloride gradient studies demonstrated that the newly synthesized DNA was the product of semiconservative replication. During the course of the DNA synthesis reaction, some of the ^{3}H-TTP used to measure DNA synthesis was degraded to TDP, TMP, Thymidine and Thymine. Double label experiments were performed to determine whether the nucleotides were incorporated directly into DNA or whether they underwent intermediate degradation and uptake as nucleosides. The results demonstrate that ^{3}H-TTP and α ^{32}P-TTP were incorporated into DNA at the same rate, indicating that in this system the nucleotides are incorporated directly into DNA. This was confirmed in a more rigorous fashion by demonstrating that L cells, deficient in Thymidine Kinase, can be permeabilized by the same technique and will then incorporate α ^{32}P-TTP and ^{3}H-TTP into DNA at the same rate. DNA synthesis requires the presence of NaCl, ATP, all four deoxynucleotides and $MgCl_2$. The reaction is inhibited by NEM, PHMB, and Actinomycin D. Hydroxyurea does not inhibit the reaction, nor does the nucleoside analog Cytosine Arabinoside. However, Cytosine Arabinoside Triphosphate does inhibit DNA synthesis and shows competitive inhibition with the deoxynucleotides.

13129 Role of reverse transcriptase in the life cycle of RNA tumor viruses. Verma, I.M.; Gibson, W. (Salk Inst., San Diego, CA). Contract EX-76-C-23-3155. pp 730-752 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

RNA tumor viruses contain a DNA polymerase (reverse transcriptase) which can faithfully transcribe the viral RNA into complementary DNA. In the scheme of events postulated by the pro-virus hypothesis, such an enzyme is required very early after infection. Purified DNA polymerase isolated from two temperature-sensitive mutants of Rous sarcoma virus (RSV), LA337 and LA335, with defects in very early events of the virus growth cycle have been shown to be more thermolabile than the DNA polymerase from the wild-type parent. Furthermore, isolated small subunit, α, from LA337 manifesting both the polymerase and ribonuclease H activities is five to seven times more thermolabile than the isolated α subunit from the wild-type parent. Thus it appears that reverse transcriptase is required to establish infection and at least the α subunit is coded for by the viral RNA. In order to investigate the nature of the large subunit, β, we purified reverse transcriptase from avian myeloblastosis virus (AMV) and RSV, in vitro, radiolabeled it with [^{125}I] and subjected it to SDS-PAGE to separate the two subunits. The tryptic hydrolysates of the α and β subunits were compared by two-dimensional fingerprinting techniques. The results indicate that β and α subunits from both AMV and RSV are structurally related. The possible mechanism of synthesis of α and β and the role of β subunits will be discussed.

13130 Correlation of the binding properties of α and αβ DNA polymerase of avian myeloblastosis virus with their different mode of ribonuclease H activity. Grandgenett, D. (St. Louis Univ. School of Medicine). Contract EX-76-C-23-3155. pp 760-765 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

αβ DNA polymerase from avian myeloblastosis virus forms more stable polymerase-nucleic acid complexes than α DNA polymerase isolated from the same virus. The stability of these polymerase-nucleic acid complexes were measured by competition experiments using first labeled and subsequently an excess of homologous unlabeled nucleic acid and by measuring the stability of these complexes under various ionic conditions. The polymerase-nucleic acid complexes were measured by utilizing the nitrocellulose membrane filter technique. These results provided direct evidence which support the conclusion that the random and processive mode of exoribonuclease H activity associated with α and αβ, respectively, is the result of the polymerase ability to bind to nucleic acids.

13131 Rolling circular DNA associated with a human hepatitis B candidate virus (Dane particles). Hung, P.P.; Mao, J.C.; Ling C.M.; Overby, L.R.; Kakefuda, T. (National Cancer Inst., Bethesda, MD). Contract EX-76-C-23-3155. pp 766-773 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

DNA isolated from Dane particles appeared in electron micrographs as double-stranded open circles and linear structures. Short double-stranded tails were found on a few (less than 2 percent) of the open circles. However, DNA isolated from Dane particles after incubation for DNA synthesis by the endogenous DNA polymerase showed that the number of the tailed circles increased to about 15 to 20 percent of the circles and the tail lengthened greatly, sometimes longer than a unit circle. These observations suggest that the circular genome of Dane particles is replicated by the rolling circle model.

13132 Repair mode of DNA replication in Escherichia coli. Hanawalt, P.; Burrell, A.; Cooper, P.; Masker, W. (Stanford Univ., CA). Contract EX-76-C-23-3155. pp 774-790 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Current models for the dark repair of ultraviolet light induced pyrimidine dimers and other structural defects in DNA include the excision-repair mode and a recombinational mode. Both of these general schemes have been well documented in bacteria and have been shown to include several alternative pathways. One of the pathways for excision-repair utilizes DNA polymerase I for the gap filling step while another invokes DNA polymerase II or III. This latter pathway is characterized by a longer average patch size than

that mediated by DNA polymerase I. The 5'-3' exonuclease of DNA polymerase I does not appear to be essential for repair replication as demonstrated in mutants deficient in this enzyme activity. Such mutants are more sensitive to ultraviolet light than the parent strain but less sensitive than a mutant deficient in the polymerase activity. The Pol I independent repair replication, like semiconservative synthesis, proceeds in the presence of ATP, as shown in toluene permeabilized cells. Unlike semiconservative synthesis, the repair mode can proceed if other nucleoside triphosphates are substituted for ATP.

13133 Excision repair of DNA. Grossman, L. Contract EX-76-C-23-3155. pp 791-814 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The following topics are reviewed: excision repair and gene products in Escherichia coli and Micrococcus lactens; role of correndonuclease in incision step; effects of endonuclease on uv- and x-irradiated DNA; pre-excision step; excision mechanisms; reinsertion mechanisms; and eukaryotic repair mechanisms. (HLW)

13134 DNA synthesis in phleomycin-treated lysates of Go lymphocyte nuclei. Reiter, H.; Hsu, P.L. (Univ. of Illinois, Chicago). Contract EX-76-C-23-3155. pp 822-831 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A DNA-synthesizing, DNA polymerase β-template complex has been prepared from lysed nuclei of Go, resting lymphocytes. ATP or GTP are required for synthesis by the untreated complex. Pancreatic endonuclease I increases only ATP or GTP-dependent synthesis, whereas phleomycin induces some synthesis in the absence of ATP, and even more synthesis in the presence of ATP or GTP. Phleomycin causes only repair synthesis in the absence of ATP but both repair and semiconservative synthesis in the presence of ATP.

13135 Discontinuous replication in prokaryotic systems. Okazaki, R.; Okazaki, T.; Hirose, S. (Nagoya Univ., Japan). Contract EX-76-C-23-3155. pp 832-862 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A new method for the detection and assay of RNA-linked nascent DNA pieces has been developed. The method relies on selective degradation by spleen exonuclease of radioactive 5'-hydroxyl-terminated DNA that is produced from the pulse-labeled nascent pieces upon alkaline hydrolysis. Analysis with this method in wild-type E. coli shows relatively high proportions of the RNA-linked molecules after shorter pulses and in the smaller pieces, supporting the transient nature of the RNA attachment to the nascent pieces. The RNA-linked nascent pieces are accumulated by both E. coli polAexl (defective in 5' → 3' exonuclease of DNA polymerase I) and E. coli polA12 (defective in polymerase of DNA polymerase I), suggesting the requirement of the concerted action of both 5' → 3' exonuclease and polymerase of DNA polymerase I for the removal of the RNA attached to the nascent pieces. Most of the nascent DNA pieces accumulated by E. coli ligts7 (defective in DNA ligase) are not linked to RNA, as expected from the direct role of DNA ligase in joining of the pieces. The analysis with spleen exonuclease also shows that a large portion of the nascent DNA pieces present in the cell under the normal steady-state conditions are not linked to RNA. The level of these RNA-free DNA pieces, as well as the level of the RNA-linked DNA pieces, is increased in polA mutants. These findings suggest that the removal of RNA from the nascent pieces is a relatively rapid process and the joining of the DNA pieces is the rate-limiting step that requires the concurrent action of DNA polymerase and DNA ligase.

CYTOLOGY

REFER ALSO TO CITATION(S) 13094, 13104

13136 (LA-UR—77-2228) **New methodlogy for measuring damage to respiratory tract cells using flow-system cell-analysis techniques.** Steinkamp, J.A.; Hansen, K.M.; Wilson, J.S.; Salzman, G.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-771113—1). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

Automated flow-system cell-analysis techniques provide a new method for determining damage to respiratory tract cells in humans exposed by inhalation of environmental pollutants such as from the production of synthetic fuels from coal and oil shale. This paper describes results of preliminary experiments designed to develop flow-system instrumentation methods for measuring biological damage to respiratory tract cells using the Syrian hamster as a model. Hamster respiratory tract cell samples were obtained by lavaging the lungs with normal saline. Cell samples stained with fluorescent dyes specific for various biochemical parameters were analyzed in liquid suspension as they flowed through a chamber intersecting a laser beam of exciting light. Sensors measured fluorescence and light-scatter optical signals on a cell-by-cell basis. Cellular parameters proportional to optical signals (e.g., cell size, DNA content, enzymatic esterase activity, nuclear and cytoplasmic diameter) were displayed as frequency distribution histograms. Basic operating features of this technology are presented, along with representative examples of results which illustrate the initial flow-system characterization of normal exfoliated respiratory tract cells.

13137 Further observations on the chemistry of pararosaniline-Feulgen staining. Gill, J.E.; Jotz, M.M. (Univ. of California, Livermore). *Histochemistry;* **46**: 147-160(1976).

Pararosaniline-Feulgen staining of cells in suspension produces nucleus- and chromatin-specific fluorescence as well as color. Experiments were designed to test postulated reaction mechanisms responsible for the fluorescent staining with the nonfluorescent pararosaniline. The reduction in fluorescent-staining intensity by pretreatment of cells with 2.2×10^{-2} M $K_2S_2O_5$ tends to rule out the alkysulfonic acid pathway; conditions favoring the formation of this intermediate reduce staining intensity. The fluorescence enhancement, observed when cells stained in pararosaniline without $K_2S_2O_5$ are post-treated with $K_2S_2O_5$, suggests that there is an initial Schiff-base linkage between pararosaniline and an aldehyde of hydrolyzed DNA, and that this linkage is stabilized in the presence of $K_2S_2O_5$. Microspectrofluorometer measurements of cells stained at various pararosaniline concentrations in 2.2×10^{-2} M $K_2S_2O_5$, show that the fluorescence emission maximum ranges from about 627 nm at 3.1×10^{-3} M pararosaniline to about 604 nm at 3.1×10^{-5} M. All of the employed staining protocols appear to produce the same fluorescent product, perhaps a heterocyclic pyronin analog formed from pararosaniline. Flow microfluorometric analysis of cells stained in suspension verified that the relative fluorescence intensity represents relative DNA content. Staining at reduced pararosaniline concentration (3.1×10^{-4} M) reduces the coefficient of variation of the flow microfluorometric histograms, showing that maximum quantitation does not necessarily correlate with maximum staining intensity.

13138 Temperature sensitive DNA: mutants of a mammalian tissue culture cell line. Roufa, D.J.; Haralson, M.A. (Baylor College of Medicine, Houston, TX). Contract EX-76-C-23-3155. pp 702-712 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Several Chinese hamster lung (CHL) cell mutants that are not able to synthesize DNA at elevated temperature have been isolated. Mutants were generated from the parental cell line by treatment with ethyl methanesulfonate and were selected in culture for conditional resistance to the photosensitizing effects of BrdU. One class of mutants (TS-13, -14 and -41), which ceases protein and RNA synthesis as well as DNA biosynthesis at nonpermissive temperature, appears to have obtained its DNA^- phenotype via a genetic lesion directly affecting protein biosynthesis. Analysis of cell-free protein synthesizing extracts from TS-14 and of TS-14's polyribosomes after transfer to nonpermissive temperatures in culture indicate that the mutant's genetic defect results in the rapid cessation of protein synthesis. Together with the striking DNA^- phenocopy effected either by cycloheximide, puromycin or mixture of toxic amino acid analogs in the wild type cell lines, these observations suggest that continuous synthesis of one or more proteins is required by CHL cells to initiate or maintain programmed DNA replication.

GENETICS

REFER ALSO TO CITATION(S) 13094, 13121, 13122, 13123, 13125

13139 (RLO/2225/T5—33) **Number of evolutionary trees.** Felsenstein, J. (Washington Univ., Seattle (USA). Dept. of Genetics). 1976. Contract EY-76-S-06-2225-005. 17p. Dep. NTIS, PC A02/MF A01.

A simple method of counting the number of possible evolutionary trees is presented. The trees are assumed to be rooted, with labelled tips but unlabelled root and unlabelled interior nodes. The method generalizes the previous work of Edwards and Cavalli-

Sforza by allowing forks to be multifurcations as well as bifurcations. It makes use of a simple recurrence relation for T(n,m), the number of trees with n labelled tips and m unlabelled interior nodes. A table of the total number of trees is presented up to n = 22. There are 282,137,824 different trees having 10 tip species, and over 8.87×10^{23} different trees having 20 tip species. The method is extended to count trees some of whose interior nodes may be labelled. The principal uses of these numbers will be to double-check algorithms and to frighten taxonomists.

13140 Mutants of Escherichia coli defective in the joining of nascent DNA fragments. Konrad, E.B.; Lehman, I.R. (Stanford Univ. School of Medicine, CA). Contract EX-76-C-23-3155. pp 304-308 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A new screening procedure has been developed which has permitted the isolation of mutants in which the joining of nascent DNA fragments is retarded. In addition to DNA ligase and DNA polymerase I defectives, these mutants include a group which, during short pulses, incorporate [^{3}H] thymidine into DNA fragments that are substantially smaller than Okazaki fragments. These small fragments can be chased into DNA of high molecular weight, and thus may be precursors in DNA replication. During longer pulses, label also appears in DNA of higher molecular weight, though at an abnormally slow rate. The mutations map at a previously undescribed locus (dnaS) at 72 minutes on the E. coli chromosome.

13141 Physical map of G4 and the origins of G4 double and single stranded DNA replication. Godson, G.N. (Yale Univ. School of Medicine, New Haven). Contract EX-76-C-23-3155. pp 386-397 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A co-linear HindI/HpaII/HaeI restriction enzyme map of G4 is presented together with the locations of the single EcoRI cleavage site and the three RNA polymerase binding sites (promoters). The location of the breaks in early and late G4 RFII DNA (i.e. the origins of double and single stranded DNA synthesis) and the polarity of the G4 cleavage map has been measured by using Pol I in an extended repair synthesis of these RFII DNA molecules. Both are located in the HindA, HpaIIB and Z5 fragments at 5% from the EcoRI cleavage site.

13142 Molecular mechanisms in the control of λ DNA replication: interaction between phage and host functions. Skalka, A.; Greenstein, M.; Reuben, R. (Roche Inst. of Molecular Biology, Nutley, NJ). Contract EX-76-C-23-3155. pp 460-485 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Our studies of the molecular events involved in the switch from early (circle) to late (rolling circle) replication of phage DNA have revealed several ways in which host and phage recombination and repair systems can exert both negative and positive control. Under one set of conditions (fec$^-$) a phage mutation (gam), which results in a failure to inhibit the host's recBC function, restricts replication to the early mode. Under a second set of conditions (feb$^-$), combined lesions in the phage general recombination (red) system and the host's repair (PolI or ligase) system produce a similar result. Our most recent experiments with the fec$^-$ system, in which the BC nuclease activity was manipulated by temperature shifts after infection with a temperature sensitive gam mutant, suggests that initiation of rolling circle replication is inhibited because the BC nuclease attacks some transient intermediate present during the switch from early to late replication and/or that it attacks at some transient stage in which the rate of DNA synthesis is limited. A dynamic model emerges from all of this in which circle replication provides a driving force that can be controlled, either to remain as such or to be shifted into rolling circle replication, depending on the disposition of recombination, repair, and possibly morphogenetic functions.

13143 Role of oop RNA primer in initiation of coliphage lambda DNA replication. Hayes, S.; Szybalski, W. (Univ. of Wisconsin, Madison). Contract EX-76-C-23-3155. pp 486-513 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The products of E. coli genes dnaB, dnaG and dnaE, the β-subunit of RNA polymerase, and lambda genes O, P, and the cis-dominant ori site are required for initiation of DNA synthesis from the ori region of coliphage lambda, which lies between genes cII and O and includes the ori site. The same genes, except for dnaE, are also required for initiation of the synthesis of two short RNAs from the l strand of lambda DNA: a 4S RNA, termed oop, promoted from within the ori region, and lit RNA (about 600 nucleotides long) starting from a site 2200 nucleotides farther downstream. Synthesis of lit requires the cis action of gene O and the ori site, and the trans action of gene P product. Replication is coupled to transcription through the requirement of the same factors for initiation of DNA synthesis and oop and lit transcription. DNA replication, per se, is not required for oop and lit transcription, since their synthesis occurs at the normal rate when lambda DNA synthesis is blocked in a dnaE$^-$ host. Thus, the initiation of lambda DNA synthesis proceeds in several stages, including: interaction of the products of genes dnaB, dnaG, O and P, the β-subunit of RNA polymerase and the ori site, which results in synthesis of oop (and lit) RNA; formation of a replication complex by interaction of DNA polymerase(s) with the oop primer RNA at the ori site; and creation of a DNA replication fork in the lambda ori region, leading to initiation of the first round of DNA synthesis. Lambda DNA synthesis, as measured by phage burst from an induced lysogen and DNA titration, is inhibited at high temperature in conditional-lethal polA hosts, suggesting that polymerase I or its 5′-3′ exonucleolytic activity is also required at some undetermined stage.

13144 Modes of plasmid DNA replication in Escherichia coli. Helinski, D.R.; Lovett, M.A.; Williams, P.H. (Univ. of California, San Diego, La Jolla). Contract EX-76-C-23-3155. pp 514-536 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Various approaches have been employed to examine the replication properties of plasmid elements in Escherichia coli. Results presented were obtained from an analysis of the effect of known chromosomal DNA replication mutants on plasmid DNA replication, the isolation and characterization of plasmid DNA replication mutants, isolation and characterization of plasmid DNA-protein complexes, analysis of plasmid DNA replication intermediates isolated from intact cells and an analysis of RNA-containing plasmid DNA molecules synthesized in intact cells in the presence of chloramphenicol.

13145 Control of RTF and r-determinants replication in composite R plasmids. Rownd, R.H.; Perlman, D.; Goto, N.; Appelbaum, E.R. (Univ. of Wisconsin, Madison). Contract EX-76-C-23-3155. pp 537-559 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

When Proteus mirabilis harboring the R plasmid NR1 is cultured in drug-free medium, the R plasmid DNA exists in the form of a basic composite structure consisting of a resistance transfer factor (RTF) component and an r-determinants component. After growth of the cells in medium containing appropriate drugs, poly-r-determinant R plasmids consisting of a single copy of the RTF component and multiple, tandem copies of the r-determinants component and autonomous poly-r-determinants (not attached to an RTF) are formed. This mechanism of gene amplification is referred to as a "transition". By reducing the rate of DNA chain elongation, it is possible to increase substantially the fraction of R plasmid DNA which is in the process of replication. The analysis of replicating molecules of R plasmid NR1 DNA by denaturation mapping has shown that the basic composite structure has two origins of replication; one is in the RTF component and the other is in the r-determinants component. Replicating R plasmid molecules isolated from the same culture of cells were found to have initiated replication at either of these two origins of replication. Possible factors which might influence the selection of an origin for the initiation of replication are discussed.

13146 Mechanism of mitochondrial DNA replication in mouse L-cells. Berk, A.J.; Clayton, D.A. (Stanford Univ., CA). Contract EX-76-C-23-3155. pp 560-577 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The replication of L-cell mitochondrial DNA (mtDNA) proceeds by a mechanism termed displacement replication in which synthesis of new daughter strands is highly asynchronous. Approximately 0.6 of the heavy strand (H-strand) is synthesized unidirectionally from a unique origin before initiation of light strand (L-strand)

synthesis begins. Early replicative intermediates are theta forms in which the parental H-strand is single-stranded and is displaced by the synthesis of daughter H-strand on the L-strand template. The parental strands of isolated replicative intermediates are closed circular indicating that replication proceeds with repeated nicking and closing of the parental strands. Daughter molecules segregate as open circular forms as demonstrated by their buoyant density in ethidium bromide-cesium chloride gradients. They are then converted to closed circular molecules with a superhelix density of sigma similarly ordered -0.007. This low superhelix density form is first converted to another closed circular intermediate with a higher absolute superhelix density, sigma similarly ordered -0.03, and then to the major mtDNA form, D-loop mtDNA. The entire replication cycle is accomplished in approximately 120 minutes. MtDNA populations isolated from mammalian cells contain catenated oligomeric forms. It is known that the formation of catenated dimers of HeLa cell mtDNA involves breakage and closure of strands. In mouse L-cells, catenated dimers of mtDNA are converted back to monomers and the rates of catenane formation and separation are very rapid.

13147 Replication of mitochondrial DNA and its initiation site. Koike, K.; Kobayashi, M.; Tanaka, S. (Cancer Inst., Tokyo). Contract EX-76-C-23-3155. pp 578-585 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Closed-circular replicating molecules of mtDNA were labeled under the conditions of the in vitro system, and these properties were examined by centrifugal analyses. From the pulse-chase experiments, the nascent DNA was found to be of two classes; one class consisted of the fragments and the other of higher-molecular DNAs. The fragments were synthesized first and then converted into the higher-molecular DNAs. The appearance of higher-molecular DNAs in both the heavy and light strands was slightly asymmetrical; an extension of the heavy strand seems to be preceding the light one. From DNA-DNA hybridization experiments, the fragments were found to anneal among themselves. The position of the initiation site was investigated by characterizing the products obtained by cleavage in vivo replicating molecules with EcoRI restriction endonuclease (EcoRI). Electron micrographical and agarose gel electrophoretic analyses revealed that at least five double-strand breaks were created at specific sites in each molecule. The longest linear structure (2.01 +- 0.07 μ) contained the replicative eye. The specific location for enzyme cleavage occurred at a fixed distance (0.45 +- 0.02 μ) from the initiation site. Based on in vitro studies and cleavage analysis, a mode of discontinuous replication of mtDNA is discussed.

13148 Cryolethal suppressors of thermosensitive dnaA mutations. Wechsler, J.A.; Zdzienicka, M. (Columbia Univ., New York). Contract EX-76-C-23-3155. pp 624-639 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

A series of suppressors of thermosensitive dnaA mutations has been isolated. The suppressors chosen for study simultaneously reverse the thermosensitivity of the original mutant and render the cell inviable at low temperature, 25°C. The suppressors can be separated into at least five genetic loci, only one of which could be identical to dnaA. Isotope incorporation experiments show that all of these strains synthesize protein normally at 25°C. Incorporation of thymine into DNA at 25°C is either similar to that observed with wild-type strains or faster. All of the suppressed strains appear to be defective in nuclear organization, chromosome segregation, or septation.

13149 Bidirectional replication in Bacillus subtilis. Wake, R.G. (Univ. of Sydney). Contract EX-76-C-23-3155. pp 650-676 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The early conclusion, which has now been rejected, that replication of the B. subtilis chromosome is a unidirectional process was based largely on certain features of the genetic map constructed from a combination of replication order and linkage data on a restricted number of markers. While several discrepancies between the map as constructed and some experimental data were apparent at the time they were probably considered minor. Autoradiographic experiments on replication fork movements established directly that replication is bidirectional over the whole chromosome. This has led to a reconsideration of the earlier discrepancies and more extensive experimentation into replication order and linkage of markers. As a result, a new map (Hartford-Lepesant), which is consistent with bidirectional replication over the whole chromosome, has been constructed. It will be seen how the misplacement of a relatively small number of genetic markers, with respect to replication order, was the major factor leading to the earlier incorrect arrangement of established linkage groups.

13150 Replication fork velocity in E. coli at various cell growth rates. Chandler, M.; Funderburgh, M.; Caro, L. (Universite de Geneve). Contract EX-76-C-23-3155. pp 688-694 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

The relative frequencies of three chromosomal markers in a strain of E. coli K12 have been measured, as a function of cell doubling time, by DNA:DNA hybridization. The results indicate that the replication time of the chromosome is a constant and independent of the doubling time of the cells.

METABOLISM

REFER ALSO TO CITATION(S) 13094, 13095, 13096, 13130, 13132

13151 Role of the Escherichia coli DNA binding protein in DNA synthesis. Gefter, M.L.; Molineux, I.J.; Pauli, A.; Sherman, L. (Massachusetts Inst. of Tech., Cambridge). Contract EX-76-C-23-3155. pp 2-13 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Escherichia coli DNA binding protein specifically stimulates the polymerase and the 3′ → 5′ exonuclease activities of DNA polymerase II of E. coli. The specificity for polymerase resides in the ability of the DNA binding protein to interact specifically, in the presence and absence of DNA, with DNA polymerase II. The enhancement of enzymatic activity is due to the fact that in the presence of DNA binding protein, DNA polymerase does not dissociate from its substrate during its action. DNA binding protein influences the enzymatic activity of DNA polymerases I and III, exonuclease I and RNA polymerase. The central role of DNA binding protein in DNA metabolism is discussed.

MEDICINE

REFER ALSO TO CITATION(S) 13161, 13165

13152 (UCRL-Trans—11285) **Clinical significance of acid phosphatase and cathepsin assay in the urine of patients with systemic lupus erythematosus.** Kainova, A.S.; Nasonova, V.A.; Samoilova, S.I.; Smepanova, N.S. Translated from *Ter. Arkh.;* **49**: No. 6, 123-126(1977). 10p. Dep. NTIS, PC A02/MF A01.

The diagnosis of renal pathology in cases of systemic lupus erythmatosus (SLE) is important in terms of administering the most appropriate treatment and achieving the best long-term therapeutic results. It is for this reason that new biochemical and other methods are needed for detecting the pathological process in the kidneys. Among the biochemical methods, enzyme assay techniques are becoming increasingly important. Despite the complexity of the pathophysiological mechanisms underlying enzymuria in SLE patients, the assay of urinary acid hydrolases, including acid phosphatases and cathepsins, provides a means of detecting active renal pathology at various stages of its development and determining the efficacy of the treatment administered.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 13019

13153 (LBL—5679) **Design and construction of the Donner 280-crystal positron ring for dynamic transverse section emission imaging.** Derenzo, S.E.; Banchero, P.G.; Cahoon, J.L.; Huesman, R.H.; Vuletich, T.; Budinger, T.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Donner Lab.). Sep 1977. Contract W-7405-ENG-48. 11p. (CONF-771205—1). Dep. NTIS, PC A02/MF A01.

From IEEE conference on decision and control; New Orleans, LA, USA (7 Dec 1977).

The design and construction of a medical imaging system for the rapid, accurate, three-dimensional imaging of positron-labeled compounds in the human body are described. Our medical research goals include quantifying blood flow and metabolism in human heart muscle and brain. The system consists of a large gantry containing

lead shielding and a ring of 280 NaI(Tl) detectors that completely encircles the patient; 280 photomultiplier tubes, preamplifiers and timing discriminators; circuits that determine whenever a crystal has detected a gamma ray in time coincidence (i.e., within 12 nsec) of any of the opposing 105 crystals and determine the addresses of the crystals involved; 120K words of 12 bit memory for the simultaneous acquisition of data from eight portions of the cardiac cycle; and a hardwired image reconstructor capable of filtering and back-projecting data from 140 views to form a 210 x 210 computed transverse section image in less than 2 sec.

13154 (UCLA—12-1132) **ECAT: a new computerized tomographic imaging system for position-emitting radiopharmaceuticals.** Phelps, M.E.; Hoffman, E.J.; Huang, S.C.; Kuhl, D.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 58p. Dep. NTIS, PC A04/MF A01.

The ECAT was designed and developed as a complete computerized positron radionuclide imaging system capable of providing high contrast, high resolution, quantitative images in 2 dimensional and tomographic formats. Flexibility, in its various image mode options, allows it to be used for a wide variety of imaging problems.

13155 (UCLA—12-1133) **"Inhalation lung imaging with radioactive aerosols and gases".** Taplin, G.V.; Chopra, S.K. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 44p. Dep. NTIS, PC A03/MF A01.

Lung imaging procedures, performed after the inhalation of / sup 99m/Tc labeled aerosols, ^{133}Xe and /sup 81m/Kr gases, were used to visualize the sites of airway obstruction and regional abnormalities of ventilatory function in normal volunteers, patients with obstructive airway disease, and pulmonary embolism suspects. Comparisons were made of three methods regarding their functional significance, diagnostic merits, and limitations. A new nebulizer-radioaerosol delivery system is described.

13156 Model for local accumulation of bone imaging radiopharmaceuticals. King, M.A.; Kilpper, R.W.; Weber, D.A. (Univ. of Rochester, NY). *J. Nucl. Med.;* **18**: No. 11, 1106-1111(Nov 1977).

A simple model, having phenomenological parameters as variables, is developed for predicting local radioactive tracer accumulation in bone. Blood delivering tracer to one gram of bone is treated as a compartment separate from the remainder of the circulation in order to observe the effects produced by variations in both bone blood flow and barrier permeability. Kinetic curves derived by analog computer were obtained for normal and perturbed values of the parameters for F-18 and Ca-47 in a segment of rabbit bone. Apparent confirmation of the predicted influence of decreased blood flow on F-18 deposition was obtained by measuring bone uptake following constriction of the right femoral artery in five rabbits. Such models may prove useful in explaining variations in uptake for different agents, in selecting imaging times, and in correlating uptake patterns with disease.

MICROBIOLOGY

13157 Thermolabile reverse transcriptase from a temperature-sensitive mutant of murine leukemia virus. Tronick, S.R. (National Cancer Inst., Bethesda, MD); Stephenson, J.R.; Verma, I.M.; Aaronson, S.A. Contract EX-76-C-23-3155. pp 753-759 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Three temperature-sensitive mutants of the Rauscher strain of murine leukemia virus are defective in early post-penetration functions required both for leukemia virus infection and for initiation of transformation of cells by their pseudotypes of murine sarcoma virus. In the present studies, the reverse transcriptase of one of these mutants (ts 29) is shown to be thermolabile compared to the enzymes of the wild-type virus and several other temperature-sensitive mutants. These findings provide evidence that the reverse transcriptase is required both for leukemia virus infection and for initiation of transformation by the replication-defective murine sarcoma virus genome.

PATHOLOGY

13158 Chronic myelocytic leukemia and the myeloproliferative diseases during the child-bearing years. Miller, J.B. (Univ. of Chicago). *J. Reprod. Med.;* **17**: No. 4, 217-224(Oct 1976).

Chronic myelocytic leukemia and the myeloproliferative diseases may present as asymptomatic elevations of peripheral blood counts or with relatively nonspecific symptoms. Full diagnostic evaluation is necessary to eliminate the many other causes of blood count elevation. Coincidence of a myeloproliferative disease and pregnancy is unusual. The pregnancy has no adverse effect on the course of the mother's hematologic disease. However, the myeloproliferative diseases, especially if uncontrolled, result in increased fetal prematurity and mortality. Treatment of the pregnant patient should be conservative, and cytotoxic therapy should be avoided until at least after the first trimester whenever possible. Busulfan has been the drug most widely used during pregnancy, and it appears not to cause fetal malformations when used alone.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 13054

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

13159 DNA polymerase I involvement in repair in toluene-treated Escherichia coli. Dorson, J.W.; Moses, R.E. (Baylor College of Medicine, Houston, TX). Contract EX-76-C-23-3155. pp 815-821 of In DNA synthesis and its regulation. Volume 3. Goulian, M. (ed.). Menlo Park, CA; W.A. Benjamin, Inc. (1975).

From Conference on DNA synthesis and its regulation; Squaw Valley, CA, USA (16 Mar 1975).

See CONF-750391—.

Toluene-treated cells have been used in the study of DNA repair after ultraviolet irradiation. Repair synthesis is lower in DNA polymerase I-containing strains than in deficient strains, possibly indicating more efficient repair. Alkaline sucrose gradients analysis reveals a faster rejoining of the parental DNA strands during repair in polA^+ strains suggesting that DNA polymerase I-mediated repair is more readily sealed by ligase. The ligation can be blocked by the addition of nicotinamide mononucleotide resulting in a pronounced uv-specific repair synthesis which is catalyzed by DNA polymerase I. The 5′ → 3′ exonuclease function of DNA polymerase I is also required for this synthesis.

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

REFER ALSO TO CITATION(S) 13127

13160 Influence of X-ray dose fractionation on the frequency of somatic mutations induced in Tradescantia stamen hairs. McNulty, P.J.; Nauman, C.H.; Sparrow, A.H.; Schwemmer, S.S.; Schairer, L.A. (Brookhaven National Lab., Upton, N.Y. (USA). Biology Dept.). *Mutat. Res.;* **44**: No. 2, 235-245(Aug 1977).

Xrays were used to investigate the influence of dose fractionation on the induction of pink and colorless somatic mutations in stamen hair cells of Tradescantia clone 02. Inflorescences were exposed to a single acute dose of 60 rad, two acute doses of 30 rad, or three acute doses of 20 rad. The dose rate in all cases was 30 rad/min. Intervals between dose fractions were varied from 35 sec to 48 h and the mutation frequency was compared with that resulting after the single dose of 60 rad. The date show a reduction in mutation frequency for fractionation intervals longer than 15 and 6 min for pink and colorless mutations, respectively, but not for shorter intervals. One interpretation of the data predicts that pink mutation frequencies are reduced by 11% for fraction intervals of 30 min to 6 h, and that colorless mutation frequencies are reduced by 24% for intervals of 15 min to 6 h. The corresponding sparing effect of dose fractionation is equal to 6 rad for pink mutations and 9 rad at the colorless mutation endpoint. A calculation has been made which indicates that the percentages of the total repairable (presumably two-hit) damage that is repaired during fraction intervals up to 6 h, are 16 and 35% for pink and colorless mutations, respectively.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 12482, 13067, 13078, 13087

13161 (EPA—520/4-77-005, pp 25-43) **Medical radiation exposure.** Aug 1977.

In Radiation protection activities, 1976.

Data are summarized on efforts by a number of Federal Agencies to reduce the radiation dose to patients undergoing diagnostic radiographic and nuclear medicine procedures.

13162 (EPA—520/4-77-005, pp 84-89) **Other nuclear sources.** Aug 1977.

In Radiation protection activities, 1976.

Measures to protect the public from fallout from nuclear detonations, nuclear powered surface ships and submarines, radioactive materials in nuclear powered pacemakers, and radiation from electronic products are reviewed.

13163 (EPA—520/4-77-005, pp 90-109) **Protection from nonionizing radiation.** Aug 1977.

In Radiation protection activities, 1976.

Standards for protection of the public against sources of nonionizing radiation are discussed. Sources include radio and television broadcast stations; radar; satellite communication system earth terminals; microwave communication systems;mobile communication systems; microwave ovens; and industrial heating equipment.

13164 (EPA—520/4-77-005, pp 110-126) **Occupational exposure.** Aug 1977.

In Radiation protection activities, 1976.

Federal responsibilities related to the radiation exposure of personnel are categorized by agencies. A list of workers in some 66 professions who may be exposed to ionizing radiations indicates the diversity of occupational exposure and of the activities of Federal agencies which regulate it. Sources of exposure include external exposure and internal exposure resulting from inhalation or ingestion of radioactive materials. Personnel monitoring activities are reviewed.

13165 (LA-UR—77-2385) **Application of protons to computer tomography.** Hanson, K.M.; Bradbury, J.N.; Cannon, T.M.; Hutson, R.L.; Laubacher, D.B.; Macek, R.; Paciotti, M.A.; Taylor, C.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 5p. (CONF-771023—8). Dep. NTIS, PC A02/MF A01.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1977).

It was demonstrated that the application of protons to computed tomography can result in a significant dose advantage relative to x rays. Thus, at the same dose as is delivered by contemporary commercial x-ray scanners, a proton scanner could produce reconstructions with a factor of 2 or more improvement in density resolution. Whether such an improvement can result in significantly better diagnoses of human disease is an open question which can only be answered by the implementation of a proton scanner in a clinical situation.

13166 (NRPB-R—52) **Human exposure to radiation following the release of radioactivity from a reactor accident: a quantitative assessment of the biological consequences.** Smith, H.; Stather, J.W. (National Radiological Protection Board, Harwell (UK)). Nov 1976. 43p.p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The objective of this review is to provide a biological basis upon which to assess the consequences of the exposure of a population to radioactivity released after a reactor accident. Depending upon the radiation dose, both early and late somatic damage could occur in the exposed population and hereditary effects may occur in their descendants. The development of dose-effect relationships has been based upon the limited amount of information available on humans, supplemented by data obtained from experiments on animals.

13167 (SAND—77-0844C) **Model to predict the radiological consequences of transportation of radioactive material through an urban environment.** Taylor, J.M.; Daniel, S.L.; DuCharme, A.R.; Finley, N.N. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 2p. (CONF-771113—6). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

A model has been developed which predicts the radiological consequences of the transportation of radioactive material in and around urban environments. This discussion of the model includes discussion of the following general topics: health effects from radiation exposure, urban area characterization, computation of dose resulting from normal transportation, computation of dose resulting from vehicular accidents or sabotage, and preliminary results and conclusions.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

13168 (SAND—77-0853C) **Assessment of the environmental impacts produced by the transport of radioactive materials through urban areas.** DuCharme, A.R.; Taylor, J.M.; Tierney, M.S.; Finley, B.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 8p. (CONF-771113—4). Dep. NTIS, PC A02/MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

Sandia Laboratories is performing an environmental assessment for the Nuclear Regulatory Commission to ascertain the impacts produced by the transportation of radioactive materials near and through a large, densely populated area. Radiological, nonradiological and economic environmental impacts due to the transportation of all radioactive materials are considered, excepting those related to weapons, weapon components, or shipments on military vehicles. Although New York City is being studied initially to execute the methodology as a function of a real, complex urban environment, the assessment model developed is general in its basic content and is suitable for application to any urban area. Radiological consequences are being computed for cases involving "normal" and accident conditions. In the "normal" case, nothing unusual takes place, but small radiation doses are still received by nearby people. In the accident case, dispersion of possibly released material away from the accident site is considered. In addition, impacts due to deviations from quality assurance practices, as a result of human error, are being calculated using the assessment model in a special manner. Certain aspects of sabotage and diversion are also being investigated for an urban setting. Radiological consequences are being quantified in terms of human health effects and decontamination costs.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 13067, 13161, 13162, 13164

13169 **Calculated doses from inhaled transuranium radionuclides and potential risk equivalence to whole-body radiation.** Strom, P.O. (US Nuclear Regulatory Commission, Rockville, Maryland, USA); Watson, E.C. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). pp 603-625 of In Transuranium nuclides in the environment. Vienna; International Atomic Energy Agency (1976).

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, CA, USA (17 Nov 1975).

See CONF-751105—.

The report examines the distribution of radiation dose commitments within the body that can result from the lung deposition of a number of transuranic radionuclides. The variables that influence these organ dose commitments include the mobility of the particle or its dissolution products within the body, the radiation characteristics of the inhaled radionuclides and their progeny, and the size of the particles inhaled. The calculated dose commitments form a part of the bases of a more speculative section of the report. Estimates of the risk of excess deaths from cancer due to whole-body radiation doses are included in the calculations to provide an estimate of cancer death risks associated with the inhalation of transuranic compounds. These results are then equated to those from whole-body radiation doses. The uncertainties associated with such calculations are recognized, and, in particular, the implicit assumptions of internally and externally generated dose equivalence and dose-effect linearity are acknowledged.

ANIMALS

REFER ALSO TO CITATION(S) 13081, 13156

THERMAL EFFECTS

PLANTS

13170 (DP-MS—77-78) **Distribution of Aeromonas hydrophila in a South Carolina cooling reservoir.** Fliermans, C.B.; Gorden, R.W.; Hazen, T.C.; Esch, G.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.; Wake Forest Univ., Winston-Salem, N.C. (USA). Dept. of Biology). 1977. Contract EY-

76-C-09-0001;EY-76-S-09-0900. 31p. (CONF-770961—1). Dep. NTIS, PC A03/MF A01.

From Microbiology of power plant thermal effluents; Iowa City, IA, USA (19 Sep 1977).

Par Pond is a thermally enriched monomictic southeastern lake which receives heated effluent from a production nuclear reactor. Fish populations in the lake have lesions of epizooty from which Aeromonas spp. are readily isolated. Distribution and population densities of Aeromonas in the water column were measured along an oxygen and temperature gradient. Greater population densities of Aeromonas occurred below the oxygen chemocline when the lake was stratified. Survival of A. hydrophila under in situ conditions in both epilimnetic and hypolimnetic waters was determined using polycarbonate membrane diffusion chambers, during two separate reactor operating conditions. Survival levels of pure cultures of A. hydrophila corresponded to the distribution patterns of the naturally occurring Aeromonas-like populations. The greater survival of A. hydrophila below the chemocline when the reactor was in full operation suggests that the fish populations may be exposed to Aeromonas for a longer period of time than when the reactor is not operating.

CHEMICALS METABOLISM AND TOXICITY

MICROORGANISMS

13171 (COO—2530-11) **Sorption of pollutant gases by soils. Progress report, December 1, 1976—November 30, 1977.** Bremner, J.M. (Iowa State Univ. of Science and Technology, Ames (USA)). Aug 1977. Contract EY-76-S-02-2530. 10p. Dep. NTIS, PC A02/MF A01.

Studies of factors affecting sorption of nitrous oxide by soils showed that nitrate inhibits reduction of N_2O to N_2 by soil microorganisms and that the inhibitory effect of nitrate on N_2O reduction increases markedly with decrease in soil pH. Emission of nitrous oxide was observed during incubation of soils under aerobic conditions. Research to account for this observation showed that N_2O is produced during nitrification of ammonium in well-aerated soils and indicated that N_2O production during nitrification of fertilizer nitrogen in soils may be significant in regard to the potential threat of fertilizer-derived N_2O to the ozone layer. A gas chromatographic procedure was developed for determination of N_2O in air. It is rapid, sensitive, specific and precise, and it permits use of the xenon in air as an internal standard. Techniques were developed for research on sorption of NO and NO_2 by soils, and studies of factors affecting NO_2 sorption by soils were initiated. The capacity of diverse soils for sorption of SO_2 was found to be very significantly correlated with their surface area, $CaCO_3$ equivalent and acid-titratable basicity. Their capacity for sorption of H_2S was found to be very significantly correlated with their clay and extractable Mn contents.

INVERTEBRATES

REFER ALSO TO CITATION(S) 11649

VERTEBRATES

REFER ALSO TO CITATION(S) 13136

HEALTH AND SAFETY

13172 **Sicherheits- und gesundheits-technische Kenndaten. (Technical characteristic data with a view to safety and health).** Sorbe, G. (Farbwerke Hoechst A.G., Knapsack (Germany, F.R.). Anwendungstechnische Abt.). Darmstadt, Germany, F.R.; G-I-T Verl. (1977). 69p. (In German).

The echo these 'Technical characteristic data with a view to safety and health' found with the public, induced author and publisher, to supplement the 12 sequences in tabular form, issued in the journal GIT since March 1972, and to publish them in the form of the compilation at hand. These characteristic data present a survey of presently known numerical values of materials in connection with which, when handled, certain safety measures have to be observed. On account of the deviating physiological impacts on man, and on account of the varying physical measuring methods, the data do not have the importance of generally valid constants. Neither can a binding character be deduced. Included was the data available up to March 75 as well as the MAK list 1976. These tables, compiled mainly for laboratory purposes are to make it possible to realize danger limits and to adapt the working process accordingly.

GEOSCIENCES

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 11595

13173 (TID—27806) **Seismicity near the Idaho National Engineering Laboratory site from November 1, 1975 to June 30, 1976.** Navarro, R.; Dahl, A.H.; West, J.C. (Idaho National Engineering Lab., Idaho Falls (USA)). Sep 1977. Contract EY-76-A-07-1379. 20p. Dep. NTIS, PC A02/MF A01.

The Las Vegas field group of the U.S. Geological Survey installed and has maintained a tripartite seismograph network on and near the Idaho National Engineering Laboratory (INEL) since October 1972. During a 20-month period from November 1, 1974 thru June 30, 1976, no seismic activity is interpreted to have occurred on the INEL site. A total of 8,161 events were recorded during the report period. Sixteen events of magnitudes between 1.1 and 2.4 (M/sub L/) occurred within the area of special study. The nearest seismic activity to the INEL was located in the vicinity of Howe, Idaho, approximately 5 km northwest of the northwest boundary of the INEL.

13174 **Seismometrical observation in Hakone Volcano, 1974.** Ito, H.; Hakamata, K.; Hiraga, S. (Hot Spring Research Inst. of Kanagawa Prefecture, Hakone, Japan). *Bull. Hot Spring Res. Inst., Kanagawa Prefect.;* **6**: No. 2, 67-78(1975). (In Japanese).

The seismic activity observed at the Hakone Volcano Observatory from January to December 1974 is described in Hakone and the adjacent areas 111 earthquakes occurred having (s-p) time interval less than 5 sec among which one was a felt shock. In relation to the Izu-Hanto-Oki earthquake (M=6.9), which occurred off the Izu Peninsula on May 9, 1974, two foreshocks for the main earthquake were well recorded together with many aftershocks. Two weeks later, the seismic activity of the Hakone volcano increased significantly. A microearthquake swarm of Hakone composed of 15 shocks occurred during 90 min between December 15 and 16. The main shock among them was -0.75 in magnitude.

GEOPHYSICAL SURVEY METHODS

13175 **Theoretical study on electromagnetic probing of permafrost terrains.** Sinha, A.K. (Geological Survey of Canada, Ottawa). *Can. J. Earth Sci.;* **14**: No. 10, 2388-2401(Oct 1977).

A theoretical analysis has shown that a portable double dipole multifrequency electromagnetic system can be a viable tool for mapping the permafrost terrains of the northern areas for engineering purposes. In this analysis, the theoretical response of a two-layer permafrost terrain (with the frozen layer at the top underlain by the unfrozen sediments) has been obtained for three coil arrangement systems. Available data on the frequency variations of the electrical properties of the permafrost and the unfrozen layers have been considered in the simulations to make the models realistic. The performance of the horizontal coplanar system is seen to be the best for mapping purposes, closely followed by that of the inclined-parallel system which is a null-coupled configuration. The study also considers the effects of the presence of a transition layer between the permafrost and unfrozen layers. The results indicate that the effects are greater when the parameters in the transition layer vary in an exponential fashion rather than in a linear fashion. The quadrature parts of the mutual coupling ratios are, in all cases, less affected by the transition layer than the in-phase parts. However, the resolution is better for the in-phase part when the permafrost thickness and frequency values are large.

13176 **Dual-wavelength thermal infrared scanner as a potential airborne geophysical exploration tool.** LeSchack, L.A.; Del Grande, N.K. *Geophysics;* **41**: No. 6, 1318-1336(Dec 1976).

The authors are investigating a new airborne method for measuring surface temperatures that may be useful for identifying thermal anomalies of geologic origin. Complicating factors, such as surface emissivity, soil composition and moisture, topography, hydrology and meteorological conditions, which can completely mask the temperature effects sought, must be removed. The techniques developed appear to be useful in making the needed correction to ir data, thus permitting the isolation of the true temperature anomalies sought.

13177 **Method for suppressing side lobes in correlation processes.** Savit, C.H. (to Western Geophysical Co.). US Patent 3,968,471. 6 Jul 1976. Filed date 10 Nov 1972. vp.

An approximate and convenient method of correlating seismic data, generated with long duration vibrator signals, randomizes the side lobes of the correlograms without materially degrading the

main lobes. Consequently, there is relative reduction of the side lobes when correlated data are summed. The two time series that are correlated are expressed in floating point form to a base of 2 and correlated using the exponents only.

13178 Geophone noise reduction method. Morris, H.B. (to Seismic Logs, Inc.). US Patent 3,963,093. 15 Jun 1976. Filed date 23 Aug 1974. vp.

A geophone is "cemented" to the bottom of a shallow hole and the top of the hole is sealed to reduce wind-generated noise.

13179 Decoupled hydrophone with reduced response to vibration and stress concentration. Bakewell, H.P. Jr. US Patent 3,961,304. 1 Jun 1976. Filed date 21 Oct 1974. vp.

A piezo-electric end-capped, air-backed cylindrical element is centered inside an aluminum cagelike housing. The cage consists of two end discs connected by three webs. The remaining space inside each hydrophone and the space between the hydrophones of an array are filled with a flexible epoxy material.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

13180 Non-destructive observation of internal cracks in stressed rocks. Nelson, A.C. (Univ. of California, Berkeley); Wang, C.Y. *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **14**: No. 2, 103-107(Mar 1977).

Using x-rays and an electrostatic image method, images of internal cracks in a stressed specimen were developed as the stress was increased. Usually images were made after a stress drop occurred. There were some problems in interpretation. (LTN)

13181 Laboratory hydraulic fracturing experiments in intact and pre-fractured rock. Zoback, M.D. (Geological Survey, Menlo Park, CA); Rummel, R.; Jung, R.; Raleigh, C.B. *Int. J. Rock Mech. Min. Sci. Geomech. Abstr.;* **14**: No. 2, 49-58(Mar 1977).

Laboratory hydraulic fracturing experiments were conducted to investigate two factors which could influence the use of the hydrofrac technique for in-situ stress determinations; the possible dependence of the breakdown pressure upon the rate of borehole pressurization, and the influence of pre-existing cracks on the orientation of generated fractures. The experiments have shown that while the rate of borehole pressurization has a marked effect on breakdown pressures, the pressure at which hydraulic fractures initiate (and thus tensile strength) is independent of the rate of borehole pressurization when the effect of fluid penetration is negligible. Thus, the experiments indicate that use of breakdown pressures rather than fracture initiation pressures may lead to an erroneous estimate of tectonic stresses. A conceptual model is proposed to explain anomalously high breakdown pressures observed when fracturing with high viscosity fluids. In this model, initial fracture propagation is presumed to be stable due to large differences between the borehole pressure and that within the fracture. In samples which contained pre-existing fractures which were "leaky" to water, we found it possible to generate hydraulic fractures oriented parallel to the direction of maximum compression if high viscosity drilling mud was used as the fracturing fluid.

13182 Solubility of alumina in orthopyroxene plus spinel as a geobarometer in complex systems. Applications to spinel-bearing alpine-type peridotites. Stroh, J.M. (Univ. of Washington, Seattle). *Contrib. Mineral. Petrol.;* **54**: No. 3, 173-188(1976).

The addition of Fe and Cr to the simple system MgO—SiO_2—Al_2O_3 markedly affects the activities of phases involved in the equilibrium—$Mg_2SiO_4 + MgAl_2SiO_6 = MgAl_2O_4 + Mg_2Si_2O_6$; Olivine + Opx/sub solid solution/ = Spinel + Opx/sub solid solution/. In particular, the activity of $MgAl_2O_4$ in many natural spinels is decreased, which gives lower calculated pressures when the formula derived from the experimental data of MacGregor (1974) is applied to complex systems containing Fe and Cr. Most "cold slab" alpine-type peridotites appear to have recrystallized at low to moderate pressure (less than or equal to 15 kb), consistent with an origin in the upper oceanic mantle and subsequent emplacement in continental crust. Taken individually or as a group, alpine-type peridotites do not record "pyroxene geotherms." Present methods of calculating re-equilibration pressure for spinel peridotites may have large systematic errors and should be applied cautiously.

GEOCHEMISTRY

13183 Trace element geochemistry of the Sokoman Iron Formation. Fryer, B.J. (Univ. of Western Ontario, London). *Can. J. Earth Sci.;* **14**: No. 7, 1598-1610(Jul 1977).

Rare earth and other trace element data are presented for samples of the Sokoman Iron Formation, Labrador, and its associated sediments. The results show that the slates associated with the iron formation are typical in trace element contents compared to other argillaceous sediments except for the large Eu depletion characteristic of slates of their age. The iron formation, however, is fundamentally different in its trace element concentrations and patterns from those of the associated rocks. It is relatively enriched in the heavy REE and Eu and both the REE and Co, Cr, Sc, and Th concentrations bear no relationship to those of the slates and the dolomite. Trace element analyses of the various textural and mineralogic rock types in all cases substantiate the genetic conclusions of earlier workers based on field and petrographic observations. Silicate-carbonate facies samples show constant REE, Co, Sc, and Th distributions which are compatible with an origin as crystalline precipitates in equilibrium with seawater. Riebeckite-bearing iron formation is distinctive in that it reflects contamination by ordinary clastic material and (or) metamorphic solutions. Oxide facies rocks exhibit widely variable trace element abundances as is to be expected for rocks whose original trace element contents were controlled by adsorption processes. A group of iron-enriched oxide facies rocks show evidence of important heavy REE complexing associated with the migration of iron during diagenesis. Minor Ce anomalies in all facies of Sokoman Iron Formation indicate that oxidation of Ce to the +4 state was taking place at the time of iron deposition but probably not in close proximity to it.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 12992

13184 Representative sampling for sea bed foundation design. Denness, B. (Inst. of Geological Sciences, London); McCann, D.M.; Lambert, J.T. pp 43-48 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

The sea floor in the South Forties field has been the subject of a comprehensive marine survey by the Institute of Geological Sciences. Part of this survey has been the collection of vibrocores for determination of geotechnical parameters of the surface sediments. This work is part of a general study on the feasibility of producing geotechnical maps for various parts of the continental shelf. Regional geotechnical maps may be produced by contouring selected geotechnical index parameters on a map to display a visual quantitative record of these parameters and a portrayal of meaningful trends. The alternative approach used here is to group samples of similar data arrays into geotechnical units of predetermined engineering significance and map their distribution. A wide range of lithological, geotechnical, and geophysical parameters was determined on selected core samples from the South Forties field. This information was analyzed to produce various types of geotechnical maps, one of which is presented here along with the method of derivation. The possibility of optimizing future detailed site investigation using correlations of design and classification parameters was investigated by principal component analysis within the data sets of each geotechnical unit.

13185 Effect of cyclic loading on clay behaviour. Andersen, K.H. (Univ. of Nottingham, Eng.); Brown, S.F.; Foss, I.; Pool, J.H.; Rosenbrand, W.F. pp 75-79 of In Design and construction of offshore structures. Blanc, J.P. (ed.). London; Institution of Civil Engineers (1977).

From Conference on design and construction of offshore structures; London, UK (Oct 1976).

See CONF-7610132—.

Offshore gravity platforms exert enormous forces on the foundation soil, both static forces from the submerged weight of the platform and cyclic forces from wave action on the platform. This paper concentrates on the effect of cyclic loading on clay behavior. Foundation behavior for a gravity platform subjected to cyclic wave loading may be separated into an undrained short-term condition and a long-term condition in which drainage occurs. Using laboratory test data, explanations are given of how cyclic displacements may increase and stability decrease during the undrained short-term condition. It is also shown that, for a foundation on normally consolidated clay, the long-term effect of cyclic loading may be beneficial with respect to stability and cyclic displacement. However, if overconsolidated clay is involved, the long-term effect of cyclic loading may be unfavorable.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

GALAXIES

13186 Far infrared spectral observations of the galactic center region from the Gerard P. Kuiper airborne observatory. Caroff, L.J.; Erickson, E.F.; Goorvitch, D.; Scargle, J.D.; Simpson, J.P.; Strecker, D.W. (National Aeronautics and Space Administration, Moffett Field, Calif. (USA). Ames Research Center). pp 126 of In Infrared and submillimeter astronomy. Fazio, G.G. (ed.) (Harvard Coll. Observatory, Cambridge, Mass. (USA)). Dordrecht, The Netherlands; D. Reidel (1977).

From Symposium on infrared and submillimeter astronomy; Philadelphia, USA (8 Jan 1976).

ATMOSPHERIC PHYSICS

13187 Relative effects on atmospheric ozone of latitude and altitude of supersonic flight. Cunnold, D.M.; Alyea, F.N.; Prinn, R.G. (Massachusetts Inst. of Tech., Cambridge). *AIAA (Am. Inst. Aeronaut. Astronaut.) J.;* **15**: No. 3, 337-345(Mar 1977).

Three calculations are reported of the potential depletion of ozone by supersonic aircraft. These calculations utilized a two-dimensional model and a three-dimensional photochemical-dynamical model of the atmosphere in which ozone and the dynamical variables of the atmosphere were derived simultaneously. All calculations were based on a continuous atmospheric injection of 1.8 x 10^6 tons/yr of NO_2. Injections at 45°N and 20 km, at equilibrium, resulted in a 36% increase in total odd nitrogen (NO/sub y/) between 8 and 38 km and in global ozone depletion of approximately 12%. Injection at 45°N and 17 km produced a 27% increase in NO/sub y/, but, because much of this increase occurred below 20 km, the ozone depletion amounted to only 6%. Injection at 10°N and 29 km resulted in a 55% increase of NO/sub y/; however, although there was more depletion above 20 km altitude, there was less below that altitude, and the ozone depletion was only 12.5%. Relative global depletions are judged to be more meaningful than absolute depletions in these calculations. In all three calculations, at least half as much ozone depletion occurred in the Southern Hemisphere as in the Northern Hemisphere.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

13188 Measurement of x-rays emitted from projectiles moving in solid targets. Fortner, R.J. (Univ. of California, Livermore); Matthews, D.L.; Feldman, L.C.; Garcia, J.D.; Oona, H. pp 559-566 of In Beam-foil spectroscopy. Vol. 2. Sellin, I.A.; Pegg, D.J. (eds.). New York; Plenum Publishing Corp. (1976).

The results of three separate experiments all dealing with the production of x-rays in projectiles moving in solids are discussed. The first experiment deals with the measurement of line widths of x-rays emitted from projectiles moving in solid targets. The effects of collisional broadening of x-rays are found to dominate the line widths giving greater than an order of magnitude increase in the measured line widths. The second experiment studies solid target effects in producing non-binomial distributions of characteristic K x-ray spectra in heavy ion-atom collisions. The third experiment studies aluminum K x-ray production in $Ar^+ \rightarrow Al$ collisions in very thin aluminum foils as a function of foil thickness. Parameterization of the observed non-linear dependence enables us to measure the lifetime of the argon 2p vacancy and total ionization cross sections for the argon L-shell in $Ar \rightarrow Al$ collisions.

13189 Ion-excited XUV radiation from solid targets. Nagel, K.J.; Knudson, A.R.; Burkhalter, P.G. (Naval Research Lab., Washington, DC). *J. Phys., B (London);* **8**: No. 17, 2779-2786(1975).

A survey of spectra excited by 3 to 4.5 MeV noble gas ions striking solid targets was made in the range from less than 50 eV to 1.5 keV (8 to 250 A) using a grazing-incidence spectrograph. K hypersatellite energies were obtained for the elements Be through Ne, and are compared with other hypersatellite data. Correct identifications of hypersatellite transitions are facilitated by use of both empirical data for nearby elements and Hartree-Fock SCF calculations. Failure of the Slater exchange approximation in SCF computations of hypersatellite energy shifts is demonstrated for both nonrelativistic and relativistic methods. No evidence for cooperative K x-ray emission was found for the elements measured.

ATOMIC AND MOLECULAR PROPERTIES

13190 Measurement of the circular-polarization correlation in photons from an atomic cascade. Clauser, J.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Nuovo Cim., B;* **33**: No. 2, 740-746(11 Jun 1976).

The results of an experiment are reported which measured the circular-polarization correlation of photons emitted in the $9^1P_1 \rightarrow 7^3S_1 \rightarrow 6^3P_0$ cascade of atomic mercury. The results appear to be in general agreement with the predictions of quantum theory. They are compared with the predictions by several inequalities derived for various alternatives to quantum theory.

13191 Uranium transitions and energy levels which may be useful in atomic-photoionization schemes for separating ^{238}U and ^{235}U. Radziemski, L.J. Jr.; Gerstenkorn, S.; Luc, P. (Univ of Calif, Los Alamos Sci Lab, NM). *Opt. Commun.;* **15**: No. 2, 273-276(Oct 1975).

A selection of transitions and energy levels from the first spectrum of uranium is presented. Some may be useful in two- or three-step atomic-photoionization methods for separating ^{238}U and ^{235}U.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

13192 Atomic capture of negative mesons. I. The Fermi-Teller model. Leon, M. (Los Alamos Scientific Lab., N.Mex. (USA)); Seki, R. (California State University, Northridge, California 91324, USA). *Nucl. Phys., A;* **282**: No. 3, 445-460(30 May 1977).

The Fermi-Teller model is developed for describing the initial atomic capture and subsequent deexcitation of negative mesons. This enables the prediction of 'initial' distribution for the lowest, quantum-mechanical part of the cascade. The results are fairly close to the traditional ad hoc 'statistical' distribution. Advantages and shortcomings of the Fermi-Teller model are discussed.

13193 Atomic capture of negative mesons. II. Fuzzy Fermi-Teller model. Leon, M.; Miller, J.H. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Phys., A;* **282**: No. 3, 461-473(30 May 1977).

The Fermi-Teller (FT) model is extended to account for the discrete nature of the energy and angular momentum loss of negative mesons undergoing capture and deexcitation through the excitation of atomic electrons. Statistical fluctuations in the energy loss permit more mesons to be captured at high energy than predicted by the FT model. The variation with atomic number (Z) of the angular momentum (l) distribution when the meson is bound with an energy comparable to K-shell electrons is similar to that predicted by the FT model. The fuzzy Fermi-Teller (FFT) model enables the authors to calculate a number of interesting quantities (e.g. the distribution of angular momentum at various stages of the cascade, the distribution of energy and angular momentum jumps, etc.) which provide insight into the details of the deexcitation process. The effect of an energy gap and polarization potential is investigated. Capture and energy loss cross sections are changed by these parameters, but they have only a small effect on the l-distribution at the K-shell. A parameter is introduced to alter the distribution of energy and angular momentum loss in the outer part of the atom. It is found that the angular momentum distribution at the K-shell is sensitive to this aspect of the model and by varying this parameter, changes are produced in the absolute kaonic X-ray yields which approach the magnitude of the periodic variations reported by Wiegand and Godfrey.

COLLISION PHENOMENA

13194 (LA-UR—77-2282) **Theoretical atomic and molecular physics at X ICPEAC.** Schneider, B.I. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 9p. (CONF-770746—1). Dep. NTIS, PC A02/MF A01.

From 10. international conference on the physics of electronic and atomic collisions; Paris, France (21 Jul 1977).

A brief discussion is presented of those theoretical contributions at the X ICPEAC which seemed most personally exciting or drew the most comments or response from other participants at the meeting. Personal bias will inevitably be obvious and for this I can only apologize to the other speakers and participants at the conference.

13195 (ORO—4881-12) **Excitation of Be^+ by electron impact.** Henry, R.J.W.; van Wyngaarden, W.L.; Matese, J.J. (Louisiana State Univ., Baton Rouge (USA). Dept. of Physics and Astronomy; Southwestern Louisiana Univ., Lafayette (USA). Dept. of Physics). Sep 1977. Contract EY—76-S-05-4881. 12p. Dep. NTIS, PC A02/MF A01.

Calculations of the collision strength for excitation of the 2p state of Be^+ are performed at incident energies of 2, 5, and 8 Ry. A modified five state close coupling expansion is used in which three pseudo-states anti 3s, anti 3p, and anti 3d are retained in addition to target states 2s and 2p. Pseudostates are chosen so that, for a given incident electron energy, there is a minimum in the dominant partial

wave collision strength with respect to variation of the range parameter. Collision strengths are obtained which lie between five state calculations of Hayes et al. and measurements of Taylor et al.

13196 Electron impact excitation cross sections for complex ions. III. Highly charged ions with three valence electrons. Parks, A.D. (Computer Sciences Corp., Silver Spring, MD); Sampson, D.H. *Astrophys. J.;* **209**: 312-318(1 Oct 1976).

The electron impact collision strengths for several types of transitions of interest in highly charged ions with three valence electrons are expressed in a simple way in terms of scaled collision strengths for hydrogenic ions and helium-like ions with Z = infinity. Among applications of interest for these results are electron impact excitation of x-ray lines of lithium-like ions observed as satellites of the lines of highly charged helium-like ions.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 13194

PROPERTIES AND STRUCTURE OF FLUIDS

13197 (IBK—1394) **Contribution of the study of high-frequency conductivity of positive column.** Babovici, V. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1977. 10p. (In Serbian). Dep. NTIS (US Sales Only), PC A02/MF A01.

In this paper we are concerned with a typical positive column plasma having the electron concentration n approximately equal to 5.10^9 cm^{-3} and the electron temperature T approximately equal to 5.10^4K. The electron drift velocity in this discharge is n approximately 5.10^5 m/s (the pressure being p=0,161 Pa) and we have that the ratio of the most probable to the drift electron velocity equals about 2. In such a situation the influence of the constant electric field in the discharge can not be ignored in the analysis of the high-frequency characteristics. Really, the experiments show (Anichin, Babovicj, Fizika 7 (1975) 71) the nonsymmetrical propagation of the high-frequency electron surface waves. On the other hand, the influence of the thermal electron motion is pronounced (Landau damping in bounded structures is remarkably increased) so that the analysis must start from the Bolzmann equation. This paper gives the generalization of the theory of A.N. Kondratenko (ZhTF, 35 (1965) 961) when the electron drift velocity exists and the whole treatment is placed in a concrete experimental situation.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

13198 (LBL—91) **Compilation of current high energy physics experiments.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1976. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

A compilation of current high energy physics experiments is presented, including in the tables the various experimental parameters as well as the spokesmen and institutions. (JFP)

13199 (LBL—6732) **Spectroscopy of new particles.** Goldhaber, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. 36p. (CONF-770712—2). Dep. NTIS, PC A03/MF A01.

From European conference on particle physics; Budapest, Hungary (4 Jul 1977).

A review of the spectroscopy of the "psions" with hidden charm or charm quantum number ch = o is followed by a discussion of charmed mesons and baryons. The anomalous C-μ events and the heavy lepton hypothesis are briefly considered. (SDF)

STRONG BARYON-INDUCED INTERACTIONS

13200 (ANL-HEP-PR—77-56) **Method of measuring the polarization of high momentum proton beams.** Underwood, D.G. (Argonne National Lab., Ill. (USA)). 1976. Contract W-31-109-ENG-38. 12p. Dep. NTIS, PC A02/MF A01.

A method of measuring the polarization of high momentum proton beams is proposed. This method utilizes the Primakoff effect and relates asymmetries at high energy to large asymmetries already measured at low energy. Such a new method is essential for the success of future experiments at energies where present methods are no longer feasible.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 13199, 13223

13201 (RLO/2230/T4—179) **Annual report 1976.** Moravcsik, M.J. (Oregon Univ., Eugene (USA)). 16 Nov 1976. Contract EY-76-S-06-2230-004. 8p. Dep. NTIS, PC A02/MF A01.

Research in theoretical high energy physics is summarized. (JFP)

WEAK INTERACTIONS

13202 (LBL—6438) **Hadronic structure of the weak neutral current.** Marriner, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1977. Contract W-7405-ENG-48. 93p. Dep. NTIS, PC A05/MF A01.

Thesis.

A comparison of neutral and charged current deep inelastic neutrino interactions is made in an experiment utilizing the Fermilab 15 ft bubble chamber. The ratio of neutral current events (NC) to charged current events (CC) is 0.35 +- .06 when the visible hadronic energy is greater than 10 GeV. The distributions of NC and CC in a new variable called u/sub vis/, which depends only on the observed hadrons, are given. From these distributions and the assumption that the x distribution is the same for NC and CC, it is concluded that for a NC y distribution of the form (1 - eta) + 3eta(1 - y)^2, eta = 0.12 +- 0.32. The ratio rho/sub NC/(rho/sub CC/) of neutron to proton cross sections in NC (CC) is studied and the quotient rho/sub NC//rho/sub CC/ = 0.7 +- 0.2. The distribution of hadrons in z/sub vis/, the scaled hadronic momentum, is given. The CC hadrons fit the predictions of the quark fragmentation functions D/sub u//sup π^+/(z) and D/sub u//sup π^-/(z) as given by Field and Feynman. The neutral current events fit the form (1 - lambda) D/sub u//sup π^+/(z) + lambda D/sub d//sup π^+/(z) for positives and (1 - lambda) D/sub u//sup π^-/(z) + lambda D/sub d//sup π^-/(z) for negatives with lambda = 0.56 +- 0.10 and a fit confidence level of 4 percent.

FIELD THEORY

13203 (ORO—3992-312) **Quantum electrodynamics within the framework of a new 4-dimensional symmetry.** Hsu, J.P. (Texas Univ., Austin (USA). Center for Particle Theory). Jun 1977. Contract EY-76-S-05-3992. 34p. Dep. NTIS, PC A03/MF A01.

Quantum electrodynamics is discussed within the framework of a new 4-dimensional symmetry in which the concept of time, the propagation of light and the transformation property of many physical quantities are drastically different from those in special relativity. However, they are consistent with experiments. The new framework allows for natural developments of additional concepts. A possible and crucial experimental test of the new 4-dimensional symmetry is discussed.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

13204 (LA—6971-PR) **Applied nuclear data research and development. Progress report, April 1—June 30, 1977.** Baxman, C.I.; Young, P.G. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1977. Contract W-7405-ENG-36. 69p. Dep. NTIS, PC A04/MF A01.

This progress report describes the activities of the Los Alamos Nuclear Data Group for the period April 1 through June 30, 1977.

EXPERIMENTAL TECHNIQUES

13205 (UCRL—52360) **Development of a minicomputer system for on-line processing of gamma—gamma coincidence events and measurements of E2/M1 mixing ratios in ^{110}Cd and ^{134}Ba.** Ruhter, W.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1977. Contract W-7405-ENG-48. 168p. Dep. NTIS, PC A08/MF A01.

Thesis.

A megachannel pulse-height analysis system using a 32,000-word PDP-8/E minicomputer and two moving-head disk memories

was developed. The system has a storage capacity of 2^{18} events at any of 2^{20} data locations, is capable of processing 1,040 events/s, and provides on-line sorting and disk storage. An X- or Y- pulse-height spectrum in coincidence with one to four arithmetically combined pulse-height windows can be assembled in core for scope display and spectral analysis within 2 to 20 seconds. The software for the system was written extensively in machine language. Excellent energy and timing resolution were achieved. An energy resolution of 2.3 keV fwhm and a timing resolution of 8.5 ns fwhm were obtained for ^{60}Co at a singles rate of 10,000 counts/s. The prompt timing peak remained Gaussian down to the fwtm by gating the TAC with SCAs which discriminated against low-energy events. The coincidence electronics also allowed on-line subtraction of accidental coincidence events. Alignment of the detectors and tests of the system's performance were made by measuring solid-angle correction factors for the Ge(Li) detectors through the correlation measurements of the 0^+—2^+—0^+ cascade in ^{106}Pd, and by measuring the angular spread of positron annihilation radiation coincidences. These experimental results were in excellent agreement with theoretical solid-angle correction factors calculated for the detector and source sizes used. Directional correlation data were obtained for gamma-ray cascades in ^{134}Ba and ^{110}Cd. Analyses of these data gave E2/M1 mixing ratios which are in excellent agreement with results obtained by other investigators. The improved resolution and data processing capabilities of this system gave new results for the 563-keV transition in ^{134}Ba and the 1505-keV transition in ^{110}Cd. E2/M1 mixing ratios of 13.3/sup +2.3/sub -1.8/ for the 563-keV transition and -1.24 +- 0.20 for the 1505-keV transition were measured.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

13206 (RLO/2232/T1—5) **Total pion cross section measurements. Annual progress report, January 1, 1976—December 31, 1976.** Jakobdson, M.J.; Jeppesen, R.H. (Montana Univ., Missoula (USA)). 17 Jan 1977. Contract EY-76-S-06-2232-001. 10p. Dep. NTIS, PC A02/MF A01.

Pion-nucleus cross section measurements were made using essentially a "good geometry" transmission method. The final data gathering run ended at LAMPF in June. Data were obtained for both π^+ and π^- mesons. The energy range covered for ^{4}He was 25 → 90 MeV, for ^{12}C was 25 → 240 MeV, for ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, ^{13}C, ^{16}O, ^{18}O, ^{27}Al, ^{40}Ca, ^{44}Ca, ^{48}Ca, ^{45}Sc, ^{51}V, Cu, Sn, ^{165}Ho, and Pb was approximately 45 → 240 MeV. In general, data were taken in 15 MeV steps below 90 MeV and 25 MeV steps above 90 MeV. Statistical accuracies of approximately 1 percent were obtained for targets of approximately 1 gram/cm^2 thickness. Time-of-flight counters identified the incident pions for energies below 70 MeV and a DISC counter identified the pions for higher energies. Data analysis for the determination of neutron radii differences for the carbon and calcium isotopes has been completed first. For ^{13}C-^{12}C, $\Delta r/sub\ n/ = 0.08 +- 0.03$ fm, for ^{44}Ca-^{40}Ca, $\Delta r/sub\ n/ = 0.01 +- 0.05$ fm and for ^{48}Ca-^{40}C, $\Delta r/sub\ n/ = 0.11 +- 0.04$ fm. The ^{48}Ca-^{40}Ca neutron radii difference agrees with recent alpha particle and proton scattering experiments.

13207 **Polarization in proton-deuteron scattering at 50 MeV.** King, N.S.P.; Romero, J.L.; Ullmann, J. (California Univ., Davis (USA). Dept. of Physics); Conzett, H.E.; Larimer, R.M.; Roy, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Phys. Lett., B;* **69**: No. 2, 151-153(1 Aug 1977).

The analyzing power for 50 MeV polarized proton scattering from deuterons has been measured for center-of-mass angles 10 to 160 degrees. Relative uncertainties are generally less than 0.01.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

13208 (ORO—5126-26) **Quasi-free scattering of kaons.** Alexander, Y.; Moffa, P.J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). Aug 1977. Contract EY-76-S-05-5126. 16p. Dep. NTIS, PC A02/MF A01.

The inclusive scattering of K^+ mesons on ^{12}C is calculated in the plane wave impulse approximation. The momentum distribution employed for ^{12}C and different reaction mechanism approaches is checked by a comparison with data of a calculation of the inclusive scattering of electrons on ^{12}C.

13209 (UCRL—80264) **Heavy ion scattering in 3D TDHF.** Weiss, M.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1977. Contract W-7405-ENG-48. 38p. (CONF-770987—1). Dep. NTIS, PC A03/MF A01.

From International symposium on nuclear collisions and their microscopic description; Bled, Yugoslavia (26 Sep 1977).

Results of three-dimensional (3D) time-dependent Hartree—Fock (TDHF) calculations are presented. The assumptions used in the calculations are summarized. The first reaction considered is ^{16}O + ^{16}O at 105 MeV (lab); isodensity contours integrated perpendicular to the reaction plane are shown for several impact parameters as a function of time. Trajectories are also shown, and the kinetics of the reaction is discussed; several other energies were also examined. Most of the deeply inelastic scattering seems to come from small impact parameters. Density contours and trajectories are next shown for ^{40}Ca + ^{40}Ca at 278 MeV (lab). Finally, density contours are shown for asymmetric systems: ^{4}He + ^{16}O at l = 5 h-bar and 50 MeV (lab) and ^{16}O + ^{40}Ca at l = 20, 40, 60, 80 h-bar and 315 MeV (lab). The light fragment seems to maintain the same average number of nucleons with which it started. 25 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 13209

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 13206

13210 (ANL/NDM—28) **Titanium-II: an evaluated nuclear data file.** Philis, C.; Howerton, R.; Smith, A.B. (Argonne National Lab., Ill. (USA)). Jun 1977. Contract W-31-109-ENG-38. 84p. Dep. NTIS, PC A05/MF A01.

A comprehensive evaluated nuclear data file for elemental titanium is outlined including definition of the data base, the evaluation procedures and judgments, and the final evaluated results. The file describes all significant neutron-induced reactions with elemental titanium and the associated photon-production processes to incident neutron energies of 20.0 MeV. In addition, isotopic-reaction files, consistent with the elemental file, are separately defined for those processes which are important to applied considerations of material-damage and neutron-dosimetry. The file is formulated in the ENDF format. This report formally documents the evaluation and, together with the numerical file, is submitted for consideration as a part of the ENDF/B-V evaluated file system. 20 figures, 9 tables.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

13211 **Nonstatistical interpretation of delayed neutron emission-simple shell model approach.** Shihab-Eldin, A.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Halverson, W.; Nuh, F.M.; Prussin, S.G. (California Univ., Berkeley (USA). Dept. of Nuclear Engineering); Rudolph, W.; Ohm, H.; Kratz, K.L. (Mainz Univ. (Germany, F.R.). Inst. fuer Kernchemie). *Phys. Lett., B;* **69**: No. 2, 143-146(1 Aug 1977).

A simple shell model calculation has been shown to account for the main features of the β-strength function of the delayed neutron precursors ^{85}As, ^{87}Br, ^{135}Sb and ^{137}I, and also for the neutron emission probabilities of these and the precursors $^{88-92}$Br. Preferential neutron emission from intermediate levels to excited states in the final nuclei is explained by considering the magnitudes of particle-hole excitations in the wave functions of levels accessible to neutron emission.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 13214

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 13211

NUCLEAR REACTIONS AND SCATTERING

13212 (LBL—6586) **Relativistic heavy ion reactions.** Poskanzer, A.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.).

Aug 1977. Contract W-7405-ENG-48. 44p. (CONF-770968—3). Dep. NTIS, PC A03/MF A01.

From International conference on nuclear structure; Tokyo, Japan (5 Sep 1977).

The present status of the study of central collisions of relativistic heavy ions is presented. The phenomenology is described, and evidence is presented for a source of nucleons from a central region caused by the overlapping densities of the target and projectile. Some of the current theoretical approaches are described including the nuclear fireball model. It appears that there is a quasi-equilibrated region at high temperature, but the signature for the expected effects of high density is not yet clear, and therefore, experimentally, the effects of high density have not been identified.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

13213 (ORNL/NUREG/TM—156) **fission product beta and gamma energy release. Quarterly progress report for April—June 1977.** Dickens, J.K.; Emery, J.F.; Freestone, R.M.; Love, T.A.; McConnell, J.W.; Northcutt, K.J.; Peelle, R.W. (Oak Ridge National Lab., Tenn. (USA)). 12 Oct 1977. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

Data were obtained for gamma-ray energy-release rates for thermal-neutron fission of ^{239}Pu. These data were partly reduced to relative (i.e. unnormalized to the number of fissions) spectra, which are very similar to those obtained for thermal-neutron fission of ^{235}U. Study of the high-energy electron response of the beta-ray detector continued, and small (less than 1 percent to 5 percent) discrepancies in theoretical and experimental spectral distributions are being investigated. Although the source of these discrepancies was not determined, an analysis of the maximum effect on ^{235}U total energy-release rates already reported was made, and this effect is less than 1 percent. 2 figures.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 13205

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 13212

13214 (UCRL—52275) **Systematics of gamma decay through low-lying vibrational levels of even—even nuclei excited by (p,p′) and (n,n′) reactions.** Koopman, R.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1977. Contract W-7405-ENG-48. 210p. Dep. NTIS, PC A10/MF A01.

Thesis.

A series of experiments was performed in which gamma-ray spectra were measured, using a Ge(Li) detector, for incident 7 to 26-MeV protons on the even-even vibrational nuclei ^{56}Fe, ^{62}Ni, ^{64}Zn, ^{108}Pd, ^{110}Cd, ^{114}Cd, ^{116}Cd, ^{116}Sn, ^{120}Sn, and ^{206}Pb, and for incident 14-MeV neutrons on natural Fe, Ni, Zn, Cd, Sn, and Pb. These measurements yielded gamma-ray cross sections from which it was inferred that almost all of the gamma cascades from (p,p′) and (n,n′) reactions passed down through the first 2^+ levels. Consequently, the strength of the $2^+ \rightarrow 0^+$ gamma transitions were found to be an indirect measure of the (p,p′) or (n,n′) cross sections. Several types of nuclear model calculations were performed and compared with experimental results. These calculations included coupled-channel calculations to reproduce the direct, collective excitation of the low-lying levels, and statistical plus pre-equilibrium model calculations to reproduce the (p,p′) and the (n,n′) cross sections for comparison with the $2^+ \rightarrow 0^+$ gamma measurements. The agreement between calculation and experiment was generally good except at high energies, where pre-equilibrium processes dominate (i.e. around 26-MeV). Here discrepancies between calculations from the two different pre-equilibrium models and between the data and the calculations were found. Significant isospin mixing of T/sub greater than/ into T/sub less than/ states was necessary in order to have the calculations match the data for the (p,p′) reactions, up to about 18-MeV.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

REFER ALSO TO CITATION(S) 13206

NUCLEAR REACTIONS AND SCATTERING

13215 (LBL—6572) **Diffusion model predictions for kinetic energy, mass, angular distributions, and γ-ray multiplicities in heavy ion induced reactions.** Moretto, L.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977. Contract W-7405-ENG-48. 16p. (CONF-770968—1). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear structure; Tokyo, Japan (5 Sep 1977).

In the present formalism the diffusion along the mass asymmetry coordinate has been generalized by refining the treatment of the radial and angular motion necessary for an adequate reproduction of the kinetic energy and angular distributions. The radial potential is used to evaluate the radial force. The interaction time and the average penetration for each l-wave are estimated. The diffusion calculation is then carried out for the duration of the interaction time. The angular rotation during diffusion is calculated for each fragment on the basis of the tangential energy. The resulting average deflection function shows the deep inelastic rainbow observed experimentally. The rainbow angle moves from positive to negative angles with increasing bombarding energy. Good agreement is obtained for the average final kinetic energy as a function of angle. The calculated Z distributions become broader as the excitation energy increases. The angular distributions for individual fragments show the characteristic disappearance of the side peaking and the development of forward peaking as the distance in Z from the projectile increases. The calculated Z angular and γ-ray multiplicity distributions are successfully compared with the experimental data.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 13216

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 13206, 13214

13216 **Study of ^{191}Os by average resonance neutron capture. Fragmentation of Nilsson model strength.** Casten, R.F.; Greenwood, R.C.; Macphail, M.R.; Chrien, R.E.; Kane, W.R.; Smith, G.J.; Cizewski, J.A. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Phys., A;* **285**: No. 2, 235-252(25 Jul 1977).

The ^{190}Os(n, γ)^{191}Os reaction was studied with the average resonance neutron capture technique at a neutron energy centered on 2 keV. Thermal capture data were also recorded. Primary transitions to states up to an excitation energy of approximately 1700 keV were detected. From the average capture data it appears possible to distinguish E1 from M1 multipolarities and thereby to map out the $1/2^-$, $3/2^-$ states in ^{191}Os. By elimination, it is possible to treat the Jsup(π) not = $1/2^-$, $3/2^-$ states as well, albeit with greater uncertainty. Combination of these results with existing data from the (d, p) reaction allows an extension of earlier treatments of the fragmentation of Nilsson strength in this mass region. Although other mechanisms may also suffice it is possible to qualitatively interpret the complex fragmentation systematics in terms of a simple model of large hexadecapole deformations varying in a reasonable manner.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

13217 **Nuclei ^{212}Pb, ^{212}Bi, ^{212}Po, ^{212}At, ^{212}Rn in a microscopic weak-coupling approach.** Schuck, P.; Wittmann, R. (Muenchen Univ. (Germany, F.R.). 1. Physikalisches Inst.); Ring, P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Lett. Nuovo Cim.;* **17**: No. 3, 107-112(18 Sep 1976).

A weak coupling scheme for the calculation of the spectra of ^{212}Pb and isotopic nuclei is presented. The proposed interaction matrix contains only the wave functions and energies of the two particle subsystems. The calculated spectra are compared with experimental spectra. It is found that in most cases the weak-coupling picture is very well confirmed, but in a few cases considerable mixing appears.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

13218 (ORNL/TM—5915) **150-m measurement of 0.880- to 100.0-keV neutron transmissions through four samples of ^{238}U.** Olsen, D.K.; de Saussure, G.; Perez, R.B.; Difilippo, F.C.; Ingle, R.W.;

Weaver, H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 51p. (ENDF—255). Dep. NTIS, PC A05/MF A01.

In order to study the ^{238}U + n total cross section, neutron transmissions through 0.076-, 0.254-, 1.080-, and 3.620-cm-thick samples of isotopically enriched ^{238}U have been measured from 0.880 to 100.0 keV using a time-of-flight technique over a path length of 150 meters with the ORELA pulsed source and a 13-mm-thick Li-glass detector. The measurement is described in detail and both a listing and figures of the resulting transmissions are given. An absolute energy scale accurate to 2 parts in 10,000 was established.

SPONTANEOUS AND INDUCED FISSION

13219 Measurement of the fission cross section of plutonium-241 from 8 eV to 70 keV. Carlson, C.W.; Behrens, J.W.; Czirr, J.B. (Univ of Calif, Lawrence Livermore Lab). *Nucl. Sci. Eng.;* **63**: No. 2, 149-152(Jun 1977).

The ratio of the ^{241}Pu fission cross section to the $^{6}Li(n,\alpha)$ cross section at neutron energies from thermal to 70 keV was measured. The Lawrence Livermore Laboratory electron Linac provided a pulsed source of neutrons, and energies were measured by time-of-flight. The evaluated ^{6}Li cross section was used to obtain σ (n,f) for ^{241}Pu from 8 eV to 70 keV and to normalize the results to the accepted thermal fission cross-section value.

NUCLEAR THEORY

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 13215

13220 (HEDL-TME—76-80) **HAUSER*4, a computer code to calculate nuclear cross sections.** Mann, F.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1976. Contract EY-76-C-14-2170. vp. Dep. NTIS, PC A05/MF A01.

HAUSER*4 is a computer code that performs statistical model calculations to predict nuclear cross sections. The code is unrestricted as to particle type, includes fission and capture, makes width-fluctuation corrections, and performs three-body calculations, all in minimum computer time. Transmission coefficients can be generated internally or supplied externally. This report describes the equations used, necessary input and the resulting output.

13221 (LA-UR—77-2393) **Modified-surface-energy methods for deriving heavy-ion potentials.** Sierk, A.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 10 Oct 1977. Contract W-7405-ENG-36. 16p. (CONF-771059—1). Dep. NTIS, PC A02/MF A01.

From Symposium on heavy-ion elastic scattering; Rochester, NY, USA (25 Oct 1977).

The use of a modified-surface-energy approach for the calculation of heavy-ion interaction potentials is discussed. It is not possible to simultaneously fit elastic scattering, ion interaction barriers, and fission barriers with the same set of constants in this model. Possible explanations of this deficiency are discussed.

13222 (ORNL/TM—6054) **ORNL ALICE: a statistical model computer code including fission competition.** Plasil, F. (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 75p. Dep. NTIS, PC A04/MF A01.

A listing of the computer code ORNL ALICE is given. This code is a modified version of computer codes ALICE and OVERLAID ALICE. It allows for higher excitation energies and for a greater number of evaporated particles than the earlier versions. The angular momentum removal option was made more general and more internally consistent. Certain roundoff errors are avoided by keeping a strict accounting of partial probabilities. Several output options were added.

13223 (RLO/2230/T4—173) **Polarization structure of nuclear and particle reactions.** Moravcsik, M.J. (Oregon Univ., Eugene (USA)). 1976. Contract EY-76-S-06-2230-004. 85p. Dep. NTIS, PC A05/MF A01.

The treatment of nuclear and particle reaction structure includes the general polarization structure, conservation laws and quantum numbers, determination of the M matrix, and tests of dynamics. (JFP)

SHIELDING CALCULATIONS AND EXPERIMENTS

REFER ALSO TO CITATION(S) 12324

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 12321

MEDICAL PHYSICS

RADIATION SOURCE CALIBRATION AND STANDARDIZATION

13224 (UCRL—79483) **Multi-technique characterization of neutron fields from moderated ^{252}Cf and $^{238}PuBe$ sources.** Griffith, R.V.; Slaughter, D.R.; Patterson, H.W.; Beach, J.L.; Frank, E.G.; Rueppel, D.W.; Fisher, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Dec 1977. Contract W-7405-ENG-48. 31p. (CONF-771209—1). Dep. NTIS, PC A03/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

At the Lawrence Livermore Laboratory, ^{252}Cf and $^{238}PuBe$ neutron sources are used for calibration of personnel neutron dosimeters and neutron monitoring instrumentation. The sources, with emission rates of approximately 2×10^{9} and 2×10^{7} n x sec^{-1}, respectively, have been calibrated by the U.S. National Bureau of Standards. The sources are transferred into a 815-m^3 concrete calibration cell through a remotely operated pneumatic system. Calibrations can be made without source moderation, or with spherical moderators of aluminum, polyethylene, water, or deuterium oxide placed over the end of the pneumatic irradiation tube. The source is located in the tube at one meter above a false floor in the center of the cell. Nine different moderators are available in sizes up to 56 cm in diameter. Several techniques used to characterize the neutron fields produced by each source—moderator configuration to improve the quality of the calibrations. Measurements and calculations are made to determine neutron flux, kerma rate, neutron spectrum, quality factor, dose equivalent rate, and linear energy transfer (LET) spectrum. Neutron spectra are determined by calculation using the ANISN discrete ordinates transport code, Bonner sphere measurements using the LOUHI unfolding code, and measurement with proton recoil counters and liquid scintillation detectors. The spectra are then folded into published energy-dependent conversion factors to yield kerma, quality factor, and dose equivalent values. LET spectra are obtained by a tissue-equivalent LET chamber and the GANDALF unfolding code. Chamber data are used to determine kerma and quality factor. Finally, a 80-cm^3 tissue-equivalent ion chamber and neutron-insensitive Geiger counter are used to measure the neutron kerma. Results of the various techniques are presented and compared. In addition, comparisons are made with results obtained from conventional health physics instrumentation such as moderated rem counters. 8 figures, 5 tables.

SOLID STATE PHYSICS

13225 (CONF-770688—1) **Symmetric radiant state in nuclear resonant Bragg scattering.** Ruby, S.L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From 38. AIP conference on new directions in mossbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A qualitative way to understand the temporal behavior of nuclear resonant Bragg scattering is described. The intermediate state in Bragg scattering is a "super-radiant" symmetric state; its rapid decay is thus explained. (RWR)

13226 Role of competing forces in displacive phase transitions. Samara, G.A. (Sandia Labs., Albuquerque, NM). *Comments Solid State Phys.;* **8**: No. 1, 13-22(1977).

It is generally accepted that the decrease in the frequency of the soft phonon mode in solids as the transition temperature is approached is caused by the cancellation between competing forces. In the case of nonferroelectric transitions, the origin of the soft-mode behavior is not generally known. This paper discusses recent work that has shed light on this problem, at least in the case of soft, short-wavelength optic phonons. These results contrast the behavior of soft ferroelectric modes with that of short-wavelength, soft optic modes observed in a variety of crystals, and they lead to the tentative conclusion that there is a reversal in the roles of the short-range and electrostatic forces in the lattice dynamics of the two cases. 1 figure, 1 table. (RWR)

13227 Rigid-body constraints and the least-squares refinement of crystal structures. Rae, A.D. (Univ. of New South Wales, Kensington, Australia). *Acta Crystallogr., Sect. A;* **32**: 895-897(Sep 1976).

To refine the orientation and location of a rigid group of atoms in a crystal, it is not necessary to store the atom coordinates relative to a localized axial system. All atoms in the asymmetric unit are defined relative to a single orthonormal axial system. A local axial system is created by taking an atom in the rigid group as origin and defining the local axes as parallel to these orthonormal axes. The evaluation of the required derivatives is then very easy. The replacement of approximate atom positions by idealized atom positions is described.

13228 Hydrodynamic theory of central peak in displacive structural phase transitions. Simanek, E.; Ward, R. (Univ. of California, Riverside). *Solid State Commun.;* **18**: 841-843(1976).

A model involving nonlinear coupling between the overdamped phonon mode and temperature fluctuations is studied using the dynamic renormalization group method. It is shown that the behavior of the central peak in the dynamic form factor depends on the specific heat exponent α. For $\alpha < 0$ and as $T \rightarrow$ T/sub c/ the central peak is found to merge with the overdamped phonon mode and the coupling goes to zero at T/sub c/ as (T - T/sub c/)/sup -α/. An argument on the intensity of the central peak in the critical region is presented and it is concluded that the hydrodynamic coupling may not be the dominant mechanism of the central peak in $SrTiO_3$.

SUPERCONDUCTIVITY

GENERAL THEORY

13229 (ORNL/TM—5986) **Effect of flux flow on self-field instability.** Dresner, L. (Oak Ridge National Lab., Tenn. (USA)). Aug 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

Flux flow causes type II superconductors to develop resistance continuously rather than suddenly as transport current increases. This means that the distribution of current among the filaments in a composite conductor is determined not only by their inductive coupling but also by the longitudinal resistance they develop as they begin to carry current. The current distribution is calculated in two cases, taking flux flow into account: a composite clamped suddenly across a constant-current source and a composite charged with current at a uniform rate. The results of the latter problem are used to show that slowly charged conductors will be much more stable against self-field instability than is indicated by purely inductive calculations.

THEORETICAL PHYSICS

OPTICS

13230 (UCRL—80300) **How to interpret an interferogram.** Bissinger, H.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Nov 1977. Contract W-7405-ENG-48. 19p. (CONF-771138—2). Dep. NTIS, PC A02/MF A01.

From Optical Society of America workshop on optical fabrication and testing; San Mateo, CA, USA (10 Nov 1977).

A method is presented of extracting three important parameters from a single set of interferograms. These parameters include surface flatness or transmitted wavefront distortions to determine maximum single-pass peak-to-valley distortions over the entire part in test, surface irregularities or gradient errors per centimeter over the clear aperture at normal incidence, and parallelism or wedge angle. This is accomplished by the use of any interferometer and simple hand tools. The analysis of the interferogram is described both experimentally and analytically. This technique is demonstrated for in-process testing by the optician or for final acceptance testing by the Quality Control Inspector. 13 figures.

ELECTRICITY AND MAGNETISM

13231 (UCRL—52321) **Evaluation of two computer programs for modeling electromagnetic interactions with surfaces.** Lehman, T.H.; Lager, D.L.; Poggio, A.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Sep 1977. Contract W-7405-ENG-48. 27p. Dep. NTIS, PC A03/MF A01.

Two computer programs designed to determine the electromagnetic scattering characteristics of thin plates were tested and evaluated in this study for the U.S. Navy. Particular attention was directed to program convergence characteristics, efficiency, and adaptability to arbitrarily shaped surfaces. One program, FINITE/ELEMENT, was based on a finite-element formulation, while the other program, BNTPLT, was based on a mixed potential approach. The operation of FINITE/ELEMENT produced convergence difficulties and used excessive computer time. Also, its use required the addition of a somewhat fictitious thickness parameter. Reformulated expressions for this program may circumvent many of these difficulties. BNTPLT performed more satisfactorily, but not significantly better than the existing NEC program to justify an extension of its use for general surfaces. Based on these findings, a course of action for the U.S. Navy is suggested with regard to their present and future needs. 12 figures.

MATHEMATICAL PHYSICS

13232 (SAND—77-1621A) **Sturm—Liouville eigenvalue problem.** Bailey, P.B. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

The viewpoint is taken that Sturn—Liouville problem is specified and the problem of computing one or more of the eigenvalues and possibly the corresponding eigenfunctions is presented for solution. The procedure follows the construction of a computer code, although such a code is not constructed, intended to solve Sturn—Liouville eigenvalue problems whether singular or nonsingular. (JFP)

13233 Computer-aided design of separable two-dimensional digital filters. Twogood, R.E. (Univ. of California, Livermore); Mitra, S.K. *IEEE Trans. Acoust., Speech, Signal Process.;* **ASSP-25**: No. 2, 165-169(Apr 1977).

A procedure for the design of separable two-dimensional digital filters is presented. The computation involved in both the filter design and implementation is shown to be efficient. Several examples are presented which illustrate the application of the technique. 6 figures.

FUSION ENERGY

13234 Note on the evolution of the fusion and plasma physics program of the E.A.E.C. (Euratom). Engelmann, F.; Palumbo, D. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 6, 187-188(1972).

A brief summary is given of the E.A.E.C. program and collaboration in fusion research.

PLASMA RESEARCH

13235 (INIS-mf—3753) **Annual report 1976. Research and training programme on controlled thermonuclear fusion and plasma physics (EUR-NE).** (Chalmers Tekniska Hoegskola, Goeteborg (Sweden). Institutionen foer Elektromagnetisk Faeltteori). 1976. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

By a new agreement the research and training programme on Controlled Thermonuclear Fusion and Plasma Physics of the Institute for Electromagnetic Field Theory at Chalmers University of Technology, Goeteborg, became associated with the Euratom Fusion programme. The planned research activity in Goeteborg which is mainly on plasma theory is summarized. A number of theoretical investigations carried out by members of the institute during 1976 is briefly reviewed. Participation in conferences and visits to research institutes by members of the institute are outlined. Publications and reports during 1976 are listed.

PLASMA CONFINEMENT AND HEATING

13236 (AED-Conf—76-506-022) **Ohmic heating in the W VII A-stellarator.** (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). 1976. 8p. (IAEA-CN—35/D2; CONF-761012—43). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 6. international conference on plasma physics and controlled nuclear fusion research; Berchtesgaden, F.R. Germany (6 Oct 1976).

First results of experiments with ohmic heating in the W VII A-stellarator are reported. At $B_0 = 2.5$ T a comparison of discharges with large (0.23) and small (0.055) rotational transform of the external helical field is made. In the parameter regime anti nsub(e) = 5 x 10^{18} - 6 x 10^{19} m^{-3}, Tsub(e) = 200 - 900 eV, Tsub(i) = 100 - 220 eV, energy confinement and MHD-instabilities are investigated. The energy density nT is proportional to the rotational transform, the toroidal field B_0, and the plasma current Jsub(p). The energy confinement time increases with nsub(e) and Tsub(e). Disruptive instabilities do not occur in discharges with large helical fields. Gas puffing during the discharge leads to higher densities (nsub(e zero) approximately 8 x 10^{19} m^{-3}), low Zsub(eff) and heating of the ions. Internal relaxations are not only observed on X-ray signals but also on various other diagnostic signals outside the plasma.

13237 (CEA-CONF—3866) **Magnetic confinement fusion in a mirror structure.** Gormezano, C. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Groupe de Recherches sur la Fusion Controlee; CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service d'Ionique Generale). 1976. 26p. (In French). (CONF-761232—3). Dep. NTIS (US Sales Only), PC A03/MF A01.

From National congress on plasma physics; Paris, France (6 Dec 1976).

Recent progress in magnetic mirror confinement research are reported. Experimental results with the 2XIIB mirror machine at the Lawrence Livermore Laboratory (USA) have demonstrated stable confinement of plasmas. By using a plasma-stream stabilization on a multi-megawatt neutral beam sustained plasma, the following parameters are attained: n greater than or approximately equal to $10^{14}cm^{-3}$, Wsub(i) approximately equal to 10keV, ntau approximately equal to $7.10^{10}cm^{-3}.s$ with betas up to 0.7. Quantitative agreement between a quasilinear theory of turbulence and experimental results is obtained over a broad range of parameters. Consequently a vigorous magnetic mirror program is started in the US with the goal of producing a practical pure fusion power reactor. A large mirror physics experiment that will both significantly extend mirror parameters and also serve as a prototype of the first experimental mirror reactor is designed. Meanwhile, experiments with the aim of improving reactor efficiency are in preparation.

13238 (IPP—6/153) **Anomalous heating by ion sound turbulence.** Dum, C.T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Mar 1977. 43p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The kinetic equation for electrons including Coulomb collisions and scattering by ion sound and related spectra is reduced to a system of equations for the energy distribution and the anisotropic part. The energy distribution is obtained for the cases where Coulomb collisions, runaway or turbulent heating dominates. Resistivity, heating rate and the dispersion relation are significantly modified for the self consistent non-Maxwellian distribution. Applications to turbulent heating by ion sound are made and other transport effects will be considered in a companion paper.

13239 (KFTI—74-36, pp 44-56) **Investigation of plasma h.f. heating in the "Uragan-1" stellarator.** Dikii, A.G.; Kalinichenko, S.S.; Kalmykov, A.A. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.) (and others). 1974. (In Russian).

In Nuclear science and engineering problems.

Excitation of high frequency waves and plasma heating as well as energy confinement and particles produced by high frequency heating of the plasma in the stellarator Uragan-1 are described. In the wide range of ion collisions corresponding to the intermediate region of nonclassical theory, energetic lifetime of the ions satisfactorily agrees with theory. The lifetime of the particles also agrees well with the nonclassical theory though the relevant range of collision was narrower. In the process of plasma heating by high frequency waves, quasisteady-state longitudinal current was observed, the value of which was very similar to that predicted from the theory of current caused by diffusion cross-section of particles in toroidal magnetic trap.

13240 (KFTI—74-36, pp 28-39) **Diffusion of charged particles during the ohmic heating of plasma in the "Uragan-1" stellarator.** Dikii, A.G.; Zalkind, V.M.; Konovalov, V.G. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.) (and others). 1974. (In Russian).

In Nuclear science and engineering problems.

The electron temperature at high and low current heating of the ohmic plasma in the stellarator Uragan-1 was studied. The parameters determining the lifetime of the charged particles were measured. The effect of current and electron temperature in the plasma on the lifetime of the particles was ascertained. Analyse of the observed results led to the identification of an anomalous behavior in the diffusion of the charge particles which is thought to be primarily due to the turbulent nature of the plasma.

13241 (KFTI—74-36, pp 4-15) **Investigation of equilibration and hydrodynamic stability of current plasma in the "Uragan-1" stellarator.** Dikii, A.G.; Zalkind, V.M.; Konovalov, V.G.; Kotsubanov, V.D.; Kuznetsov, Yu.K. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. (In Russian).

In Nuclear science and engineering problems.

The conditions of current heating of the plasma in the stellarator Uragan-1 and the methods of measurement of the parameters are described. The equilibrium and the stability of the plasma pinch were analyzed. The conditions for automatic stabilization of perturbed current plasma were also studied. The observed results are discussed in detail. The equilibrium of the current pinch were conserved under all conditions. The energy content of the plasma was, however, limited and this was ascribed to increased heat convection under conditions of growing dissipative hydrodynamic instability of the current plasma.

13242 (LA-UR—77-2472) **Parametric study of plasma startup systems for tokamaks.** Vogel, H.F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 4p. (CONF-771029—26). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

Plasma initiation from a poloidal coil set is discussed for inducing the startup voltage where no magnetic flux is generated in the plasma region. A mathematical expression is reported which states the current distribution necessary in a toroidal shell for the zero field condition inside. The combination of the startup coil in one physical unit with the vertical field coil is considered. A flux plot is discussed for the case that the coil set is mounted outside the toroidal field coils and iron used for reducing the magnetic field energy.

13243 (PPPL—1374) **ICRF heating in tokamaks.** Takahashi, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 80p. Dep. NTIS, PC A05/MF A01.

The current status of ICRF heating of Tokamak plasmas is described. Two aspects of the subject are discussed: the physics of wave damping and the evaluation of ion heating. Recent experiments in several Tokamak devices at the second harmonic of the deuteron cyclotron frequency have exhibited large discrepancies between the observed and predicted wave damping. A possible explanation, based upon enhanced cyclotron harmonic damping due to the proximity of the two-ion hybrid and cyclotron resonance layers, is discussed. The boundary value problem for fast wave propagation in an inhomogeneous two-ion plasma has been solved explicitly to obtain the wave field structure. For modest proton concentrations (less than 5 percent) a steep gradient in the left-hand polarized electric field is found in the region between the hybrid and cyclotron resonant layers. This gradient appears to provide sufficient enhancement of the second harmonic damping strength to account for the observed discrepancies. However, a reliable measurement of the proton concentration is needed to choose between the two possibilities. Ion heating was examined in detail in recent experiments in the ATC device. It is shown that ICRF heating can heat the bulk of the ions in the core of a Tokamak plasma with efficiencies ranging from 10 to 40 percent, without causing any significant change in the ion energy confinement.

13244 (UCRL—79880) **Design of an electrostatic end-plugged plasma-confinement device.** Moir, R.W.; Dolan, T.J.; Barr, W.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Sep 1977. Contract W-7405-ENG-48. 8p. (CONF-771029—49). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A laboratory-scale experimental device having an outside diameter of 1.2 m has been designed to test the idea of electrostatic end plugging of an open-ended magnetic-field configuration. The configuration is a toroidal quadrupole having four very thin (less than 1-mm-thick) line cusps produced by four circular copper coils. Iron is used to concentrate the magnetic flux density to 2.0 T; without the use of iron, the power consumption, which is about 1 MW, would be about 25 times higher. The use of iron also produces a precisely known magnetic field and allows good access for diagnostics and pumping. Iron is also used for both the flux return path and the vacuum chamber. A hollow anode with an adjustable (nominally 1-mm-wide) gap is biased from 10 to 20 kV. Plasma densities of about 10^{13} cm^{-3} and temperatures of about 1 keV might be produced by an electron beam and by electron cyclotron resonance heating. Higher-order multipoles (hexapoles and octopoles) also are described.

13245 **Confinement of a fusion plasma by a cold gas blanket.** Ahlborn, B. (Univ of BC, Vancouver). *Can. J. Phys.;* **55**: No. 12, 1047-1054(15 Jun 1977).

The particle end losses from a linear magnetic fusion reactor can be suppressed by establishing an ablation front in a cold gas blanket. The power density $W(W/cm^2)$ to drive the thermal front may be drawn from inside (energy end losses) or outside (auxillary heating). With W below $10^9 W/cm^2$ and a D-T blanket the particle outflow is retarded. With higher W values the flow is completely stopped and the fusion plasma is recompressed by a shock wave traveling inwards from the ends. 17 refs.

13246 **Ion temperature and energy balance in stable discharges in the LT-3 Tokamak.** Bell, M.G. (Australian National Univ., Canberra. Dept. of Engineering Physics). *Plasma Phys.;* **19**: No. 5, 467-477(May 1977).

The ion temperature in the Tokamak LT-3 has been deduced from measurements of the thermal Doppler broadening of oxygen impurity line emission from the hydrogen plasma. The profiles of lines in the u.v. region of the spectrum were analysed with a polychromator which measures simultaneously 7 contiguous spectral bands separated by 0.25 A in wavelength. With this instrument, ion temperatures as low as 10 eV could be measured reliably. In stable discharges, which occur in LT-3 only for a sufficiently high q-value at the plasma column boundary, the central ion temperature rises to a maximum of about 30 eV after 4 ms from the initiation of the discharge. The ion energy confinement time at the centre of the discharge reaches a maximum value of about 400 μs.

13247 **State of stellarator research.** Shohet, J.L. *Comments Plasma Phys. Controlled Fusion;* **3**: No. 1, 25-38(Apr 1977).

The present state of stellarator research in the world is assessed. Stellarators have recently been shown to be extremely effective toroidal magnetic confinement systems with high energy confinement times, flat density and temperature profiles and qs at the limiter that can be of the order of 0.5. In addition, currentless operation is effective and permits the establishment of the confining fields before plasma is introduced. No disruptive instabilities have ever been reported by present day ohmically-heated stellarators when the helical rotational transform is large enough to outweigh the current rotational transform.

13248 Temperature effects on the laser beat heating of a plasma. Willet, J.E.; Ellialtioglu, R. (Missouri Univ., Columbia (USA)). *Plasma Phys.;* **19**: No. 4, 395-398(Apr 1977).

Brief note.

A study is presented of beat frequency heating of a plasma of arbitrary temperature by antiparallel laser beams. The primary objective is to present an analysis which includes the complete nonrelativistic thermal correction to the power absorption as required at very high temperatures and which does not require the beat frequency to be equal to the plasma frequency. The analysis employs Maxwell's equations for the electric and magnetic fields E and B in conjunction with the Boltzmann equation for the electron distribution function f. The collision integral may be conveniently approximated by $\nu(\bar{f}-f)$, where ν is electron-ion collision frequency and $\bar{f}$ is the isotropic part of the distribution function, i.e. $\bar{f} = (4\pi)^{-1} \int f \, d\Omega$ is the solid angle average of f in velocity space.

13249 Energy confinement in mirror plasmas. Baldwin, D.E. *Comments Plasma Phys. Controlled Fusion;* **2**: No. 6, 173-184(Jan 1977).

The theoretical status of confinement in mirror machines is summarized as a basis for a program aimed at improving the energy multiplication of mirror reactors. Several methods which have been advanced are briefly reviewed.

13250 Tandem mirror reactor. Fowler, T.K.; Logan, B.G. *Comments Plasma Phys. Controlled Fusion;* **2**: No. 6, 167-172(Jan 1977).

A new plasma confinement scheme is described which employs magnetic mirror plasmas to stopper the ends of a long solenoid. The overall system Q, defined as the ratio of fusion power to total plasma injection power, can exceed that of a conventional mirror by an arbitrary factor, depending on the size and power of the system.

13251 Study on storage and losses of plasma in a multislit electromagnetic trap. Lavrent'ev, O.A.; Sappa, N.N.; Sidorkin, V.A. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Ukr. Fiz. Zh. (Russ. Ed.);* **21**: No. 4, 637-639(Apr 1976). (In Russian).

Injection of electrons into a multislit electromagnetic trap is investigated experimentally. The plasma formed as a result of ionization of a residual gas is retained by a system of external magnetic and electric fields. The places of electron loss are determined for the front and back regions of the trap. An increase in the internal volume of the trap by a factor of two does not result in increasing the local loss of electrons, and the time of plasma containment increases proportionally to the volume of retention.

13252 TERP, a non circular toroidal pinch. Allen, A.W.; Goldenbaum, G.C. (Maryland Univ., College Park (USA)). pp 517-520 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Turbulent heating in high voltage, low density ($<10^{14}cm^{-3}$) theta pinches is a proven technique for heating large volumes of plasma to thermonuclear temperatures. The TERP experiment is designed to investigate some of the problems that arise in trying to transfer these concepts from straight theta pinch geometry to a toroidal confinement system. Various considerations have led to a small aspect ratio turbulent heating experiment with A approximately equal to 2 - 3 which in turn has led to consideration of noncircular cross section Tokamak-like confinement systems. The investigations began by studying the relaxation to equilibrium and the excitation of MHD instabilities after the initial implosion. Two cases have been studied, one with a filling pressure of 1 mTorr of argon and the other with 10 mTorr of hydrogen. The implosion phase is much more rapid and diffusive in hydrogen but the late time MHD behavior appears to be similar for both plasmas although the macroscopic velocities are again faster in hydrogen.

13253 Detailed observations on the dynamics and heating of a linear theta-pinch. Deuchars, W.M.; Irving, J.; Kidd, D.E.; Gabriel, S.B.; McNaught, W.G.; Brown, R.; Stinson, D. (Strathclyde Univ., Glasgow (UK)). pp 221-225 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A detailed study is presented of the characteristics of a theta-pinch plasma formed in pre-ionised hydrogen with initial electron density in the range 2 - 5 x $10^{20}m^{-3}$ corresponding to filling densities in the range 0.7 - 1.4 x $10^{21}m^{-3}$ [10 - 20 mtorr]. The observations reported here are consistent with those reported previously. The onset of microinstabilities in the initial current sheath leading to anomalously high resistivity and electron heating, allows rapid field diffusion and leads to a fast implosion which sweeps up only a fraction of the initial filling gas. The origin of the radial filamentary structure which also appears at this time is not known. The subsequent compression dynamics are consistent with magnetohydrodynamic oscillations followed by a slow adiabatic compression leading to a final compression ratio eta of approximately 2.5.

13254 Experimental study of end losses from a low energy theta-pinch. El-Menshawy, M.F. (Libya Univ., Tripoli). pp 357-361 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The investigations were carried out to study the end losses in the crowbarred theta-pinch discharge (60 kV, 2μF, 3.2μsec, 235 kA, 3.6kJ). The study of the end losses requires a knowledge of the temporal and axial distribution of the electron density and temperature, and quantitatively spectroscopic methods were used for this purpose. In addition the gross dimensional behaviour of the discharges was investigated by taking streak records and by magnetic probe measurements. The graphs of the temporal and axial variation of the line densities and flow velocity are provided in this paper. Significant plasma losses evidently occur even during the implosion.

13255 High density linear systems for fusion power. Ellis, W.R.; Krakowski, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 587-591 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The physics and technological limitations and uncertainties associated with these routes to fusion power production via the LTP are discussed in terms of a generalized energy balance, which has as its basis the ratio (Qsub(E)) of total electrical energy generated to net electrical energy consumed. Included in this total is the virtual energy of bred fissile fuel, if a hybrid blanket is used, as well as the actual or real energy deposited in the blanket by the fusion neutron. The advantages and disadvantages of the pulsed operation demanded by the LTP are also discussed.

13256 Liner compression of a toroidal high-β plasma. Es'kov, A.G.; Kurtmullaev, R.Kh.; Malyutin, A.I.; Semenov, V.N.; Shipuk, Y.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 489-492 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

An imploding metal liner enables us to achieve plasma pressures of approximately 10^5-10^6 atmospheres and effective inertial confinement. Of particular interest is the use of a magnetic field with closed lines of force for thermo isolation. The arrangement of an experiment in which three-dimensional adiabatic liner compression of plasma toroid with closed magnetic field and elongated cross section is realized is described. The required structure formation and plasma preheating to Tsub(i) approximately 200-300 eV (n approximately $10^{16}cm^{-3}$) take place in the shock chamber, where a toroidal plasma current Isub(p) approximately 1.5 MA (Bsub(phi) approximately 10 kG) is excited together with a pulsed stabilizing field Bsub(THETA), sufficient to meet the Kruskal-Shafranov limit. The shock heating process involving rapid plasma compression along the system axis proves to be the most advantageous with respect to maximum plasma temperature and energy storage technology.

13257 Interactions of high energy plasma clusters with a longitudinal magnetic field. Goryacheva, N.V.; Zhitlukhin, A.M.; Lotoskii, A.P.; Lyashenko, V.M.; Ravichev, S.A.; Skvortsov, Yu.V.; Strunnikov, V.M.; Tserevitinov, S.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). pp 467-469 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Considerable progress has been made in the area of designing and studying powerful coaxial plasma accelerators. It is known that the efficiency of such devices to convert electric energy stored in the capacitor banks into kinetic energy of dense high temperature plasmas is rather high (30 /50%). The MK-200 plasma accelerators in operation at the Kurchatov Institute allow generation of plasma flows with the following parameters: the total amount of particles is $10^{20}/10^{22}$ for the density of $10^{16}/5$ $10^{17}cm^{-3}$, Tsub(e)-10/50 ev, and

plasma velocity (2/8).10^7cm sec^{-1}. The kinetic energy of such flows is greater than 100 kJ, and the stagnation temperature reaches 1/1.5 kev. Both the calculations and experimental data obtained with these accelerators [1] indicate that the plasma parameters could be subsequently improved. Progress in injector design has increased the feasibility of a fusion reactor in which plasma is heated outside the confinement region.

13258 Equilibrium, stability and confinement in the ELMO Bumpy Torus. Hedrick, C.L.; Nelson, D.B.; Owen, L.W.; Sayer, R.O. (Oak Ridge National Lab., Tenn. (USA)). pp 291-293 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The basic premise of the ELMO Bumpy Torus (EBT) is that plasma currents produced by high-beta hot-electron annuli can provide macroscopically stable plasma confinement in a bumpy torus. Experiments carried out in a EBT during the past year have indicated the validity of this premise. Here we present a summary of the theoretical calculations in support of this premise. Calculations of 3D, finite-beta equilibria and the effect of finite beta on particle orbits are also discussed.

13259 Implosion measurements in a high voltage, large diameter, medium density theta-pinch. Henins, I.; Hammel, J.E.; Jarboe, T.R.; Marshall, J.; Sherwood, A.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 203-207 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Implosion Heating Experiment (IHX) is a large diameter (40 cm), one meter long, high voltage (up to 250 kV on the coil) linear theta pinch designed to study the implosion phase of conventional theta pinch heating under the conditions of a constant magnetic driving field. The objectives of the study are to understand better the physics of the implosion process, and to increase the amount of implosion heating by using higher implosion electric fields than has been usual in theta pinches at Los Alamos. This experiment is designed for a deuterium plasma density of about 10^{15} cm^{-3} and a maximum current of 800 kA rising in 125 ns and remaining approximately constant for 500 ns. These conditions would produce a plasma electric field Esub(theta) of 2 kV/cm. So far, however, we have operated at less than maximum current while diagnostics are being developed and data are obtained for comparison to those to be taken at higher implosion fields.

13260 Screw pinches and high beta tokamaks with circular cross-section. Hirano, K.-I. (Nagoya Univ. (Japan). Inst. of Plasma Physics). pp 87-91 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A survey of these machines is given, including dimensions, results achieved to date, and future problems to be tackled, such as plasma heating, and the application of scaling laws. The conclusion is that, although promising as possible reactor systems, no clear conclusions can be drawn at present.

13261 Toroidal equilibrium of non-circular sharp boundary plasma surrounded by force-free fields. Hoekzema, J.A. (Association Euratom-FOM, FOM-Institut voor Plasmafysica, Rijnhuizen, Jutphaas, (Netherlands)). pp 535-539 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The MHD equilibrium of an axisymmetric free-boundary plasma with homogeneous pressure and an internal bias field is studied numerically. The plasma is surrounded by force-free fields such as commonly produced during the formation of a pinch. Results are presented for configurations enclosed by a metal shell with either circular or elongated cross-section. In the circular geometry a pronounced elongation of the plasma is found even for moderate equilibrium displacements. In the belt geometry, equilibria with highly elongated plasma cross-section are possible, also at high compression ratios.

13262 Application of reversed ultra-fast theta-pinch to a tokamak plasma. Inoue, N.; Nihei, H.; Yamazaki, K.; Ichimura, M.; Matsuda, T.; Morikawa, J.; Uchida, T. (Tokyo Univ. (Japan). Faculty of Engineering). pp 215-219 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A reversed ultra-fast theta-pinch using a Blumlein circuit is applied to an ordinary tokamak plasma to provide of further heating. A large amplitude magnetic wave is excited and propagates radially into the plasma and is expected to heat it turbulently by its passage, the plasma cross-section remaining unchanged. A preliminary experiment in a straight machine showed some interesting results. A small, fat torus has been constructed whose major diameter is 50 cm and minor is 24 cm. The conducting shell also serves as the thetatron coil. The toroidal magnetic field is, 7 kG and the plasma current of 30 kA flows for about 10 ms. The Blumlein line charged to 100 kV is closed at the time of the plasma current maximum. The induced azimuthal electric field is estimated to be 0.4 kV/cm along the tube wall in the case of vacuum. The rise time of the magnetic field is 200 ns.

13263 Absorption of CO_2-laser radiation in a hypocycloidal-pinch plasma. Lee, J.H. (Vanderbilt Univ., Nashville, Tenn. (USA)); McFarland, D.R. (National Aeronautics and Space Administration, Langley Station, Va. (USA). Langley Research Center). pp 413-417 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Absorption of a 50-J pulsed CO_2 laser beam in the plasma produced in a hypocycloidal-pinch apparatus was studied. The apparatus consists of three disc electrodes with a 5-cm hole on the axis. The current sheets are snow-plowed toward the center of the hole to produce a plasma with a density $>10^{18}$ cm^{-3} and a temperature near 1 keV which emits soft x-rays for 5μs. IR detectors measured the laser radiation incident onto, transmitted through, and scattered from the plasma as functions of time. For a period up to 70μs from the onset of x-ray emission, neither transmitted nor scattered laser radiation was observed above the detector threshold of 0.3% of the incident flux. This indicates effective absorption of the lase beam (>99%) and that the particle confinement time extends far beyond the energy confinement time of 5 μs. Thus, the plasma in this apparatus appears much more amenable to laser heating than that in a theta pinch.

13264 Plasma containment in a toroidal bicusp (Tormac). Levine, M.A.; Brown, I.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Gallagher, C.C. (Air Force Cambridge Research Labs., L.G. Hanscom Field, Mass. (USA)). pp 381-386 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The stable containment of a fully ionized, high-β plasma in a toroidal 'bicusp' (Tormac) is reported. The internally trapped magnetic field in Tormac gives a number of very desirable features. First of all, the inclusion of a magnetic field, which is without curl across the plasma boundary and within the plasma region, does not alter the absolute minimum-B characteristics of the plasma. Secondly, by trapping the magnetic field within the plasma the existence of zero magnetic field is eliminated and the motion of particles within the cusp is adiabatically interconnected. Thirdly, the plasma is divided into two regions, a region of open field lines and a region of closed field lines. Finally, magnetic shear is introduced into the sheath region in order to enhance sheath stability.

13265 Staged theta pinch experiments. Linford, R.K.; Downing, J.N.; Gribble, R.F.; Jacobson, A.R.; Platts, D.A.; Thomas, K.S. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 193-196 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Two implosion heating circuits are being experimentally tested. The principal experiment in the program is the 4.5-m-long Staged Theta Pinch (STP). It uses two relatively low energy (50kJ and 100 kJ), high voltage (125 kV) capacitor banks to produce the theta pinch plasma inside the 20 cm i.d. quartz discharge tube. A lower voltage (50 kV), higher energy (750 kJ) capacitor bank is used to contain the plasma and provide a variable amount of adiabatic compression. Because the experiment produces a higher ratio of implosion heating to compressional heating than conventional theta pinches, it should be capable of producing high temperature plasmas with a much larger ratio of plasma radius to discharge tube radius than has been possible in the past. The Resonant Heating Experiment (RHX) in its initial configuration is the same as a 0.9-m-long section of the high voltage part of the STP experiment and all the plasma results here were obtained with the experiment in that configuration. Part of the implosion bank will be removed and a low inductance crowbar added to convert it to the resonant heating configuration.

13266 Laser-plasma interaction in the Scylla 1-C theta pinch. McKenna, K.F.; Zimmermann, E.L.; Freese, K.B. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 375-379 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Scylla 1-C experiment was initiated in order to investigate the interaction of a high power (approximately 10^9 W) CO_2 laser beam with a dense (nsub(e) approximately > 10^{17} cm^{-3}) theta-

pinch plasma. The experiment is directed toward the investigation of a) channeling of the laser beam along the large aspect ratio (L/D approximately 100) plasma column, b) plasma heating by laser energy absorption and c) anomalous backscatter of laser light. In this paper the results of an investigation of the theta-pinch plasma parameters , the CO_2 laser operating characteristics and the phenomenology of the laser-plasma interaction are discussed.

13267 High beta plasma confinement in reversed field pinch (ETL TPE-1). Ogawa, K.; Shimada, T.; Kiyama, S.; Hirano, Y.; Maejima, Y. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). pp 255-259 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

ETL TPE-1 is an experimental apparatus for the confinement of high-beta toroidal plasma produced by the fast magnetic field compression technique in an axisymmetric magnetic system. The main experimental results of equilibrium and stability in a screw pinch configuration in the plasma temperature range $>$ 100 eV are: in the low q region it was very hard to confine the stable equilibrium plasma due to MHD kink instabilities; in the high q region, stable plasma in the so-called high-beta tokamak configuration was confined for longer, approximately 40-50 μs, with β approximately 3%.

13268 New concept for mega-volt shock compression and millisecond confinement in the belt pinch. Wilhelm, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 531-534 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The next generation of toroidal high-beta-experiments has to aim at the attainment of plasmas with keV-temperatures and with confinement times of msecs. Enormous technical difficulties are expected when conventional shock heating techniques are to be applied. To overcome these problems a new concept for fast magnetic field pulsing has been developed and tested in which the flux is moved inside a fully closed coil system using iron as a flux absorbing element. Theoretical behaviour of the system is analysed mathematically, and results from a large scale model experiment are presented.

13269 (DOE-tr—3) **Controllable forming of a compact toroidal structure with an impulse field barrier.** Yeskov, A.G.; Kalygin, A.G.; Kurtmullayev, R.Kh.; Kutuzov, M.I.; Laukhin, Ya.N.; Malyutin, A.I.; Markin, A.I.; Proshletsov, A.P.; Semeyenov, V.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976. Translation of IAE—2750. 20p. Dep. NTIS, PC A02/MF A01.

Research is described on thermonuclear systems with a compact toroidal structure and a percussion heating of plasma with a poloidal field. The results are presented on the experiment on suppressing the radial plasma losses and magnetic fluxes with an impulse quadrupole field at the inversion stage of the external field and the rejoining of the counter magnetic fluxes. Computations and results are presented of the heating model on a computer, based on linear percussion compression of the toroidal plasma in the coaxial and volume variations.

13270 Role of high frequency preionization in increasing efficiency of plasma heating. Fedyakova, V.P. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). *Zh. Tekh. Fiz.;* **45**: No. 8, 1639-1640(Aug 1975). (In Russian).

13271 Equipment for the production of high-temperature plasmas for thermonuclear reactions. Kapitza, P. (to AN SSSR, Moscow. Inst. Fizicheskikh Problem). German(FRG) Patent 2010710/C/. 3 Jul 1975. 17p. (In German).

13 figs.

The invention refers to a device for generating high-temperature plasmas making possible nuclear fusion reactors, where an electric discharge takes place in a discharge vessel filled with a working gas by the influence of electromagnetic high-frequency oscillations on the working gas guaranteeing a maximum concentration of the electric field in a discharge zone, as far as mode and frequency are concerned. According to the invention, a steady, stable, and dense fusion plasma is achieved by introducing the working gas into the discharge vessel designed as resonator by means of jets tangential to the walls of the resonator. The working gas thereby is compressed to atmospheric or higher pressure values and caused to rotate around an axis lying horizontally with respect to the resonator. The resonator, which may be designed as a hollow cylinder or an annular toroid, is arranged within a solenoid, generating a constant magnetic field in the resonator if direct current flows through the solenoid. In the interior of the resonator a coil is arranged, enclosing the zone of the electric discharge and generating an unsteady magnetic field if an alternating current flows through the coil, which, together with the constant magnetic field, causes magneto-acoustic oscillations or an adiabatic compression of the plasma.

13272 Electron-cyclotron collisionless plasma heating. Golovanivskii, K.S.; Dugar-Zhabon, V.D.; Milant'ev, V.P. (Universitet Druzhby Narodov, Moscow (USSR)). *Fiz. Plazmy;* **1**: No. 4, 655-661(Jul 1975). (In Russian).

The electron distribution function over transverse energy is obtained while the electron cyclotron resonance in a constant homogeneous magnetic field with allowance for weak relativistic effects. It is shown that after establishment of the stationary distribution no energy transfers to plasma from HF field. On the basis of the distribution function obtained HF potential perturbations, have been studied, and it is shown that there are two types of oscillations: natural oscillations of plasma at rest and blowoff oscillations. Expressions are obtained for increments of the instabilities under consideration. The instability of the right-handed rotating electromagnetic wave propagating along a magnetic field is also studied. This type of a wave is shown to oscillate at frequencies depending on the anisotropy, that is analogous to the case of a temperature-anisotropic plasma.

13273 Plasma heating and confinement in systems with beta$<<$1. Rabinovich, M.S. (Lebedev Phys Inst, USSR Acad of Sci). pp 509-539 of In International conference on phenom in ionized gases. Prague; Institute of Physics (1973).

From 11. international conference on phenom in ionized gases; Prague, Czech (10 Sep 1973).

This survey of the contemporary state of fusion research begins with a discussion of the primary purpose of this research. The article then covers: diffusion in toroids; studies of plasma confinement in Tokamaks and Stellarators; and ion confinement, ohmic, and high-frequency heating. 30 refs.

13274 Plasma heating and confinement in the Livermore superconducting levitron. Hartman, C.W.; Anderson, O.A.; Birdsall, D.H. (Univ. of California, Livermore). pp C6 of In European Physical Society 3rd international symposium on toroidal plasma confinement. Garching, Germany; Max-Planck-Inst. of Plasmaphysics (1973).

From 3. international symposium on toroidal plasma confinement; Garching, Germany (26 Mar 1973).

Stable confinement of approximately isotropic hot-electron plasma is observed for various beta ratios. Confinement at large β/ sub phi/ without anomalous loss is found to result from a cold-plasma background of low density. Heating of dense plasma occurs by thermalization with the hot-electron plasma at a collision-determined rate without significant anomalous loss of hot electrons.

13275 Neutral injection and OHMIC plasmas in the Culham levitron. Alcock, M.W.; Bradford, R.E.; Freeman, R.; Hammond, D.P.; Riviere, A.C.; Sweeetman, D.R. (UKAEA, Abingdon, England). pp 131-134 of In European Physical Society 6th conference on controlled fusion and plasma physics. Volume I. Moscow; Joint Inst. of Nuclear Research (1973).

From 6. European conference on controlled fusion and plasma physics; Moscow, USSR (30 Jul 1973).

Initial results are presented on the production of plasma by neutral injection and by ohmic heating. The observed containment times of the order of 0.1 second, are consistent with the results of FM1 at Princeton at the equivalent toroidal field strength. No anomalous loss of hot ions was observed but a negative plasma potential considerably greater than KT/sub e//E was present during injection.

13276 Steady-state, high-beta, hot-electron plasmas. Guest, G. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 1, 29-32(1972).

The basic technique of resonant microwave heating of electrons is described. Instability losses during microwave heating are discussed.

13277 Properties of axisymmetric confinement systems with noncircular cross section. Schluter, J.; Hintz, E. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 5, 143-153(1972).

The properties of axisymmetric toroidal confinement systems and the effects of such systems together with additional heating methods are discussed and existing experimental results are summarised.

PLASMA DIAGNOSTICS

13278 (AEOI—44) **Laser produced plasma density measurement by Mach-Zehnder interferometry.** Vaziri, A.; Kohanzadeh, Y.; Mosavi, R.K. (Atomic Energy Organization of Iran, Teheran. Nuclear Research Centre). Jun 1976. 8p. (NRC—76-30). Dep. NTIS (US Sales Only), PC A02/MF A01.

This report describes an optical interferometric method of measuring the refractive index of the laser-produced plasma, giving estimates of its electron density. The plasma is produced by the

interaction of a high power pulsed CO_2 laser beam with a solid target in the vacuum. The time varying plasma has a transient electron density. This transient electron density gives rise to a changing plasma refractive index. A Mach-Zehnder ruby laser interferometer is used to measure this refractive index change.

13279 (FUPH-R—138) **Determination of plasma density and temperature profiles using magnetoacoustic oscillations.** Brennan, M.H.; Jessup, B.L.; Jones, I.R. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). Dec 1976. 22p. Dep. NTIS (US Sales Only), PC A02/MF A01.

This paper reports on theoretical and experimental refinements in the use of forced radial magnetoacoustic oscillations of a magnetized plasma as a diagnostic technique. The theory of such oscillations is extended to include radial variations in electron number density, neutral atom density and plasma temperature. In experiments carried out in an argon afterglow plasma, observations of the radial variation of the oscillation amplitude, and of the total flux in the plasma, are combined with theory to yield radial density and temperature profiles. These profiles are in good agreement with independent measurements made using laser interferometry and spectroscopic techniques.

13280 (IPF—76-1) **Electron density measurements on the plasma focus.** Rueckle, B. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1976. 84p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The paper presents a determination of the maximum electron density in a plasma focus, produced with the NESSI experimental setup, by the method of laser beam deflection. For each discharge a time-resolved measurement was performed at four different places. Neutron efficiency as well as the time of the initial X-ray emission was registrated. The principle and the economic aspects of the beam deflection method are presented in detail. The experimental findings and the resulting knowledge of the neutron efficiency are discussed.

13281 (KFTI—74-36, pp 60-64) **Turbulent noises of current-carrying plasma in the stellarator.** Barkov, A.P.; Burchenko, P.Ya.; Volkov, E.D.; Kutsyn, A.A.; Maznichenko, M.E. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. (In Russian).

In Nuclear science and engineering problems.

The intensity of microfields was measured and the turbulent noise level was determined. The method of observing the satellites near the forbidden He [7440-59-7] spectral lines was used. The method is suitable for a noncontact spectroscopic determination of frequency, intensity and direction of electric microfields in the plasma.

13282 (PPPL—1381) **Doppler model for adiabatic toroidal compressor driftwave frequency profiles.** Koch, R.A.; Tang, W.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 12p. Dep. NTIS, PC A02/MF A01.

Microwave and CO_2 laser scattering experiments on ATC (Adiabatic Toroidal Compressor) Tokamak have shown that there exists a spectrum of fluctuations with parallel bar f parallel bar = parallel bar $\omega/2\pi$ parallel bar less than or equal to 1 MHz at wavelengths lambda approximately 0.28 cm and with parallel bar f parallel bar less than or equal to 400 kHz for lambda approximately 1 cm. However, a typical maximum frequency calculated for given experimental density and temperature profiles is f less than or equal to 150 kHz for the longer wavelengths and differs with the experimental results by roughly a factor of 2 or 3. At shorter wavelengths the calculated maximum f is less than or equal to 100 kHz, which differs quite substantially with the experimental result. This discrepancy is interpreted as evidence of vector E x vector B Doppler shift from a radial electric field.

13283 **Laser light scattering as a method for measuring the magnetic field direction in a plasma.** Carolan, P.G. (UKAEA Research Group, Abingdon. Culham Lab.). *Plasma Phys.;* **19**: No. 8, 757-775(Aug 1977).

The spectrum of light scattered by a plasma in a magnetic field consists of a sequence of peaks if the scattering vector k is almost perpendicular to the magnetic field B. Serious smearing of the peaks occurs when 2kvsub(e)cosphi >= ωsub(ce) where phi is the angle between k and B. Hence the scattered light will exhibit modulation only within a thin angular wedge. The angular location of this wedge can be determined by using a Fabry-Perot or a Michelson interferometer and from this the direction of the magnetic field can be determined. A generalized treatment is presented to allow for the interpretation of experimental results from any light scattering arrangement or plasma field configuration. The limits imposed on this diagnostic technique, such as the laser beam divergence and field uniformity, are also derived. For a representative Tokamak plasma of Bsub(tor) = 3T, Bsub(pol) = 0.3T and Tesub(e) = 1 keV, the poloidal field must be uniform within 0.015T in the scattering volume for 30° scattering by a ruby laser beam whose divergence must be less than 3 mrad to obtain an accuracy of about 5% in the determination of the ratio Bsub(pol)/Bsub(tor).

13284 (UCRL-Trans—11272) **Electron-optical cameras for laser and laser-plasma diagnostics.** Serdyuchenko, Yu.N.; Chevokin, V.K.; Shchelev, M.Ya. (AN SSSR, Moscow. Fizicheskij Inst.). Aug 1977. Translation of Lebedev Physics Institute, USSR Academy of Sciences, Preprint No. 29, Moscow, 1977; 35 pp. 14p. Dep. NTIS, PC A02/MF A01.

The paper describes the stages of design and construction of experimental ultrahigh-speed electron-optical cameras (EOC) for studying lasers and laser plasma. Included among these cameras are universal instruments used for single-frame photography and linear scanning in the millisecond, microsecond and nanosecond time ranges, and also specialized cameras characterized by either a high time resolution (approximately 10^{-12} sec) or the ability to operate in the x-ray spectral range (1 to 10 A) with a resolution up to 10^{-11} sec, or cameras for recording single nanosecond frames with a large effective image field and a high spatial resolution. The technical characteristics of the newly created cameras are given, and problems involved in the construction of pulsed circuits for controlling image converters and the characteristics of electronic circuits of static tube supply are discussed. The application aspects of EOC in physical experiments are briefly mentioned, and ways of further improving the cameras are outlined.

13285 **Soft X-ray emission from picosecond laser plasmas.** Tuilier, M.H. (Paris-6 Univ., 75 (France). Lab. de Chimie Physique); Lacour, B. *J. Phys., B (London);* **10**: No. 8, 1407-1412(1 Jun 1977).

The soft X-rays emitted in the 6 to 8.5 A range from dense plasmas produced in solid aluminium targets by ultrashort laser pulses have been analysed. Lines resulting from lithium-like, helium-like and hydrogen-like ion transitions were identified. The intensity ratio of the Al XI transition $1s2p^2\ ^2D$-$1s^22p\ ^2P$ with respect to the Al XII resonance line decreases when the pulse duration varies between 15 to 50 ps. Various plasma parameters T, Tsub(z) and nsub(c) were estimated in both cases.

13286 **Cyclotron emissivity of a plasma of arbitrary density.** Audenaerde, K. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). *Plasma Phys.;* **19**: No. 4, 299-314(Apr 1977).

The spectral emissivity of a non-relativistic plasma of arbitrary density for frequencies above the electron cyclotron frequency is derived. A general formula is given which then is explicitly discussed for the case of thermal equilibrium. For emission perpendicular to the static magnetic field an analytic formula has been obtained. For arbitrary directions, the results are calculated numerically and given in graphical form. In the limit of vanishing electron density the usual results are recovered.

13287 **Theoretical cross-spectrum of the microfield measured by two small dipoles in a warm isotropic plasma.** Pottelette, R.; Chauliaguet, C.; Storey, L.R.O. (Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France)). *J. Plasma Phys.;* **17**: No. , 201-231(Apr 1977).

It is suggested that the electron density and temperature of a plasma could be determined by immersing two small dipole antennae in it, and by measuring, as a function of frequency, the cross-spectrum of the random signals that they receive. When the plasma is in thermal equilibrium, this spectrum is related simply, by Nyquist's theorem, to the real part of the mutual impedance of the two antennae. The case is studied where, in addition, the plasma is collisionless and no magnetic field is present. The spectrum has a main resonance peak slightly above the plasma frequency, while for still higher frequencies it exhibits oscillations, the amplitudes of which decrease as one moves away from the plasma frequency. The main resonance peak becomes sharper, but smaller, as the distance between the antennae becomes large compared with the Debye length.

13288 **Measurement of electron energy distributions in moving striations.** van den Berge, G. (Ghent Rijksuniversiteit (Belgium). Natuurkundig Lab.). *Physica, B, C;* **83**: No. 2, 227-230(Jun 1976).

A sampling technique is discussed for measuring the time-resolved electron energy distribution in moving striations by means of the Langmuir-Druyvesteyn probe method. The technique is used in a neon discharge (p_0=0.79 torr; Isub(d)=105 mA; 2r=5.6 cm). It is found that the electron energy distribution strongly depends upon the striation phase; in the region of strong electric field it is double peaked.

13289 **Plasma focus.** Bernard, A. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). pp 69-86 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The first part of the paper describes improved neutron and X-ray diagnostic methods devised for the Plasma Focus, and the results obtained on experiments with Mather-type machines (mainly at the Centre d'Etudes, Limeil). The second part relates the essential

features of the Plasma Focus to the instabilities and turbulence caused by the large electrical current flowing into the plasma. Different machines are compared.

13290 Interferometry and MHD turbulence measurements in toroidal pinches. Dutt, T.L. (Polytechnic of North London (UK)); Evans, D.E.; Wilcock, P.D. (UKAEA Research Group, Abingdon. Culham Lab.); Thomas, C.D.V. (Royal Holloway Coll., Englefield Green (UK)). pp 455-460 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A 10.6 micron interferometer produced 2 to 3 good quality fringes in the HBTX plasma. There is substantial agreement in the electron densities determined by interferometry and by Thomson scattering, but since the former is an absolute measurement and is systematically lower than the Thomson scattering values, the latter may be too great by about 35%. In RF Pinches, turbulence associated with the instability deflects the beam and corrupts the interferogram. However, if the intensity fluctuations induced in this beam by the turbulence, are measured, as is done in the second experiment performed in the FRSX plasma with a HCN laser, the frequency spectrum of the turbulence can be deduced. In this plasma, rms fluctuations in the density were measured by this means to be 20%, and the dominant frequency of the fluctuations multiplied by the tube diameter was approximately Alfven speed, favouring an interpretation of the gross turbulence in this plasma in terms of Alfen waves.

13291 Spectroscopic studies of high beta plasma. El-Menshawy, M.F. (Libya Univ., Tripoli). pp 363-367 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Detailed spectroscopic measurements of electron density and temperature of high beta plasma from relatively low energy (approximately = 12.5kJ) theta pinch discharge are reported (electron density approximately = 3 x 10^{17} cm^{-3}, electron temperature approximately = 40eV, ion temperature approximately = 70eV). The measured HeII4686A line profile was unfolded; and ion temperature and electron density were estimated from Doppler and Stark components respectively. The line density calculated from the electron density and the plasma diameter, was nearly constant with time for about 1μsec after implosion, indicating that the plasma was well contained by the anti-parallel trapped magnetic field.

13292 Optical diagnostics on Scyllac. Freese, K.B.; Jahoda, F.C.; Kristal, R.; Seibel, F.T.; Siemon, R.E. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 99-104 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Scyllac toroidal theta pinch optical diagnostic complement consists of three types of measurements: plasma self-luminosity, laser interferometry, and laser light scattering. Each is described separately.

13293 Study of the reversed field pinch on HBTX I using Thomson scattering. Gowers, C.W.; Jones, P.A. (UKAEA Weapons Group, Aldermaston. Atomic Weapons Research Establishment). pp 443-448 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Since 1971 a wide range of plasma conditions on HBTX I have been studied using Thomson scattering. The original system has now been modified to include a multiply pulsed ruby laser capable of up to four individually timed pulses in one discharge and some preliminary results are presented. To handle the quantity of information the modified system can produce and to shorten the inner pulse time a data acquisition system linked to the on line computer has also been developed and preliminary commissioning successfully completed.

13294 Characteristics of high-density theta-pinches seeded with selected high-z elements. Thomson, D.B.; Jones, L.A.; Bailey, A.G.; Engleman, R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 209-213 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A 60-kV, 180-kJ capacitor bank, crowbarred at peak current, produced a Bsub(z) field of 90 kG at T/4 = 3.0 μs in a 25-cm long, 8.2-cm-long-i.d. theta coil. The theta pinch, called Scyllar, has been operated with hydrogen, deuterium, or helium, seeded with a few percent of Ne, CO_2, $Fe(CO)_5$, or other elements. Radiation in the VUV range is observed with a 2.2-m grazing incidence vacuum spectrograph. Diagnostics have included pulsed laser holographic interferometry, time-resolved observations of HeII 4686 A line profiles, and two-foil soft x-ray temperature measurements. For diagnostics development, the bank has been operated at 1/3 capacitance with a field of 45 kG at T/4 = 2.0 μs. Characteristics of the seeded plasmas are summarized.

13295 Application of a submillimeter laser as an interferometer for studying a decaying plasma. Berezhnyi, V.L.; Kononenko, V.I. *Zh. Tekh. Fiz.;* **45**: No. 10, 2116-2118(Oct 1975). (In Russian).

The paper reports on the use of a submillimeter HCN laser as an interferometer for the investigation of a decaying plasma. The HCN laser operates with a methane-air mixture in the regime of continuous generation (lambda = 377 mcm, radiation power approximately 30 mW). The laser radiation has been detected by a detector on the base of point contact of metal - InSb at T = 300 t K. A three-mirror interferometer has been used to measure electron density in the range of 10^{13} to 10^{16} cm^{-3} and to investigate the time dependence of plasma density of an electrodeless induction discharge. Oscillograms are given of discharge current and interference signal at a discharge initial pressure p = $4x10^{-2}$ mm Hg and Usub(ch) = 15 kV, the period is 9 mks. It should be noted that there is no interference at the acive stage of the discharge and that the interference amplitude damps completely at the initial stage of a plasma decay. The lower limit is 10^{13} cm^{-3}, that is in a good agreement with microwave measurements of electron density at a wavelength of lambda = 8.2 mm. The maximum density is limited by the value of $6x10^{14}$ cm^{-3}. Taking into account the results obtained in measuring the density and temperature of plasma electrons at the discharge active stage (Nsub(e) approximately equal to $9x10^{15}$ cm^{-3}, Tsub(e) = 1.5-2.10^5 K), the authors come to the conclusion that the strong attenuation of submillimetre radiation in plasma which causes disappearing interference is due in the main to the Coulomb absorption. It has been shown that the interferometer may be used to determine the frequency of electron-ion collisions and the plasma temperature in the range of 10^3 to 10^5 K.

13296 Phase cross-modulation of electromagnetic waves on cylindrical plasma. Gorovenko, A.P.; Fialko, E.I.; Bairachenko, I.V. (Kievskij Gosudarstvennyj Univ. (Ukrainian SSR)). *Ukr. Fiz. Zh. (Russ. Ed.);* **20**: No. 3, 497-499(Mar 1975). (In Russian).

The non-linear effect of phase-cross-modulation is used to determine the properties of a plasma. Expressions for the phase cross-modulation as a function of the parameters of the waves and the plasma are given. It is shown that this effect can be easily measured in experiments.

13297 Cyclotron radiation from toroidal plasmas. Engelmann, F.; Curatolo, M. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 4, 121-128(1972).

Cyclotron radiation from a hot plasma, confined in toroidal geometry has features which make it interesting and important for the generation of tokamaks presently in preparation and these are reviewed. A thorough investigation into its possible use as a diagnostic tool is suggested.

PLASMA KINETICS - GENERAL

13298 (INIS-mf—3850) **Wills plasma physics department thirty third 6-monthly progress Report 1st January-30th June 1977.** (Sydney Univ. (Australia). School of Physics). 1977. 7p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Progress is reported on research programs which are proceeding in the following topics: plasma sources, hydromagnetic shock waves, rotating plasmas, magnetohydrodynamics, laser diagnostics and far infrared interferometry.

13299 (INIS-mf—3851) **Wills plasma physics department thirty second 6-monthly progress report 1st July-31st December 1976.** (Sydney Univ. (Australia). School of Physics). 1976. 8p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Progress is reported on research programs which are proceeding in the following topics: plasma sources, hydromagnetic shock waves, rotating plasmas, magnetohydrodynamics, laser diagnostics and far infrared interferometry.

13300 (KFTI—74-36, pp 57-59) **Diffusion of current-discharge afterglow plasma in the stellarator.** Burchenko, P.Ya.; Volkov, E.D.; Lats'ko, E.M.; Rudakov, V.A. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. (In Russian).

In Nuclear science and engineering problems.

The time-development of plasma density, electron temperature, glow of the 4686 A line and of the ohmic heating current are presented. Two time-intervals characterized by different rates of changes in the amplitude and frequency of the fluctuations can be distinguished during the plasma decay. In the 300-600 μsec interval, a quick vibrational quenching occurs which is accompanied by a change in the radial distribution of the plasma density.

13301 Recombination of a helium plasma. Biberman, L.M.; Iakubov, I.T.; Vorobjev, V.S. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *J. Phys., B (London);* **10**: No. 8, 1585-1589(1 Jun 1977).

The paper deals with specific features of the collisional-radiative recombination of a helium plasma. The theoretical results obtained are compared with the experimental data and numerical calculations. The peculiarities established formerly are confirmed by the behaviour of the recombination coefficient with increase in the electron temperature.

13302 Neutron-, ion-, and electron-energy spectra in a 1 kJ plasma focus. Krompholz, H.; Michel, L.; Schoenbach, K.H.; Fischer, H. (Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Angewandte Physik). *Appl. Phys.;* **13**: No. 1, 29-35(Mar 1977).

The neutron energy spectrum (4 Torr deuterium) was determined from 30 m flight histograms. An average energy of approximately 100 +- 20 keV of the neutron producing deuterons within an assumed cone angle of approximately 40 degrees along the Z-axis was calculated by means of the target beam model. Shadow bar techniques reveal that only 10% of the neutrons are produced in the approximately 1 cm long focus. Experimental time of flight analysis confirms that the ion spectrum extends from less than 70 to greater than 400 keV. The electron spectrum in 8 Torr hydrogen follows an approximately 3 keV Boltzmann distribution, but demonstrates the presence of nonthermal > 100 keV electrons.

13303 Ionization by charge transfer. Macek, J. (Nebraska Univ., Lincoln (USA). Behlen Lab. of Physics). *Comments At. Mol. Phys.;* **6**: No. 5, 169-176(1977).

Charge-transfer reactions are increasingly recognized as playing an important role in ionizing neutral atoms in a variety of situations. Examples include the ionization of neutral hydrogen by highly charged ions in plasmas, inner-shell ionization in heavy ion collisions in solids and gases, and ionization of gases by 40 keV protons. Data on charge transfer in such cases were reviewed at the American Physical Society Division of Electron and Atomic Physics Meeting in Lincoln, Nebraska. This note reports on the proceedings of the symposium on charge transfer at this meeting. 11 references.

13304 Relaxation of toroidal discharges. Taylor, J.B. (UKAEA Research Group, Abingdon. Culham Lab.). pp 59-67 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A remarkable feature of toroidal discharges is that after the initial violently unstable phase, during which the plasma is formed, the discharge relaxes into a quiescent state which is grossly stable. This quiescent state depends only on a few external parameters, such as the initial toroidal field Bsub(o) and the induced current I, and not on the previous history of the discharge. In fact the relaxed state is characterised by the pinch ratio theta = 2I/aBsub(o) and if this exceeds some critical value the quiescent state is accompanied by a spontaneously generated reversed toroidal field in the outer regions of the plasma. It is quite clear, therefore, that there is a strong tendency for the plasma to find its own state irrespective of its initial configuration. This paper reviews a theory which accounts for this remarkable behaviour and also for a very wide range of other phenomena occurring in toroidal discharges.

13305 Nuclear fusion reactions in fronts propagating in solid DT. Bobin, J.L. (Comm a l'Energie At, Cent d'Etud de Limeil, Villeneuve-Saint-Georges, Fr). pp 465-494 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

Nuclear fusion reactions in solid deuterium-tritium mixtures are reviewed, with emphasis on the following questions: can such a front be self sustained by thermonuclear reaction. If and when the preceding regime does not exist, can externally driven shocks yield a sufficient amount of energy from thermonuclear reaction in order to get a positive energy balance. 52 refs.

13306 Optical transitions stimulated by plasma turbulence. Bekefi, G. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 1, 9-16(1972).

Stark splitting of energy levels of a turbulent plasma is discussed. Experimental and theoretical data of stark splitting are reviewed.

PLASMA KINETICS - EXPERIMENTAL

13307 (KFTI—74-36, pp 40-43) Current-carrying plasma noises and epithermal u.h.f.-radiation in regime with run-away electrons. Vasil'ev, M.P.; Dikii, A.G.; Kulaga, A.E.; Litvinov, A.P.; Perepelkin, N.F. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1974. (In Russian).

In Nuclear science and engineering problems.

The ultra-high frequency (UHF) spectra of a He [7440-59-7] plasma in the stellarator Uragan were measured. The intensity of the radiation was highly irregular in the wavelength region studied and the spectral shape was dependent on the magnetic field used. UHF radiation of short wavelength possesses a noise component, whereas that of long wavelength (lambda approximately 3.1-2.1 cm) has a sporadic non-steady-state character. When the low frequency noise level in the stellarator is small, the observed oscillogram indicates hard x-ray and radio noise of the plasma. The intensity of hard x-rays decreased with the strength of the electric field and with an increase in the initial pressure of the working gas or the magnetic field. The radio noise spectra of current-carrying plasma were determined with the help of external magnetic antenna, and the observed spectra were analyzed.

13308 (PPPL—1375) Observations of multiply ionized tungsten radiation in the PLT discharges. Hinnov, E.; Mattioli, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 11p. Dep. NTIS, PC A02/MF A01.

Spectral and spatial distributions of radiation bands with peaks at 33, 51 and 60 A, ascribed to 4d-4f transitions of tungsten ions in the range about W XX to W XXXV, have been measured in discharges of different electron temperatures.

13309 Experimental study of transitions between excited states of hydrogen induced by electron impact. Himmel, G.; Pinnekamp, F. (Bochum Univ. (Germany, F.R.). Inst. fuer Experimentalphysik 2). *J. Phys., B (London);* **10**: No. 8, 1457-1464(1 Jun 1977).

Resonance scattering of laser light has been used to study electronic depopulation rates in a low-temperature hydrogen plasma for excited states with quantum numbers n = 3, 4, 6 and 7. It turns out that the relatively low cross sections for this process predicted by semiclassical impact-parameter models fit the measured data within the experimental errors.

13310 Continuum radiation measurements in an argon plasma between 120 nm and 340 nm. Preston, R.C. (National Physical Lab., Teddington (UK)). *J. Phys., B (London);* **10**: No. 8, 1573-1583(1 Jun 1977).

A 3 mm channel diameter wall-stabilised arc run in argon at a pressure of 1.75 x 10^5 Pa has been used to determine absolute values for the argon continuum volume emission coefficients and argon continuum emission factors between 120 nm and 340 nm at axial temperatures of 12 760 K and 13 780 K. Absolute calibration was by means of blackbody-limited lines and sealed deuterium lamps. The uncertainties assigned to the continuum emission factors of +- 8% represent a significant advance in accuracy over previous measurements.

13311 Electron temperature and density relaxations during internal disruptions in TFR Tokamak plasmas. Enriques, L.; Sand, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). *Plasma Phys.;* **19**: No. 4, 349-361(Apr 1977).

Several diagnostics (soft X-ray, Thompson scattering, high frequency waves, and vacuum ultraviolet spectroscopy) have been used on TFR Tokamak plasmas in order to show that the soft X-ray relaxations are mainly due to electron temperature relaxations, with only small variations of the electron density. Values of ΔTsub(eo)/Tsub(eo) up to 17% and of Δnsub(eo)/nsub(eo) of a few % or less have been measured.

13312 Excitation of multilayered plasma columns with the ring of magnetic currents. Sharma, S.C.; Verma, J.S. (Birla Inst. of Tech. and Science, Pilani (India). Plasma Research Div.). *Pramana;* **7**: No. 6, 385-388(Dec 1976).

The excitation of gaseous plasma column having semiconductor plasma columns on either side is studied with the excitation source being the ring of magnetic currents. The whole structure being cylindrical in shape, contains the conductor along its axis. The effect of radii of all the columns including that of the ring of radiation pattern, is studied which shows a peak of maximum radiation in a certain direction along with some other less intense peaks. In most cases the peak occurs roughly at 61deg at which fine structure is given. Also three intense peaks of radiation occur when radius of the plasma (outer semiconductor) column is 0.058 m.

13313 Pulsed radiation from focused plasmas. Bostick, W.H.; Nardi, V.; Prior, W. (Stevens Inst. of Tech., Hoboken, N.J. (USA)); Cortese, C. (Istituto Elettrotecnico Nazionale, Turin (Italy)). pp 407-412 of In Pulsed high beta plasmas. Proceedings of the third topical conference held at UKAEA Culham Laboratory, Abingdon, Oxfordshire, UK 9-12 September 1975. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Simultaneous measurements on pulsed emission of hard x-rays (>30 keV), microwaves (lambda = 3-10 cm), and D-D neutrons are made in focused deuterium plasmas. The correlation among emission processes is determined by time resolution and time-coincidence

analysis. The total neutron yield N increases with the maximum energy Esub(Max) observed for D-D neutrons. A functional dependence N = N(Esub(Max)) approximately equal to A Esub(Max)sup(n) is obtained which fits the observations for 4.2 MeV >= Esub(Max) >= 2.9 MeV. Radiation anisotropy is recorded.

13314 Studies of the ion temperature and total radiated energy from pinches in HBTX I. Bunting, C.A.; Newton, A.A.; Watts, M.R.C. (UKAEA Research Group, Abingdon. Culham Lab.). pp 437-441 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The neutral atom velocity distribution of a 60 kA Stabilized Z pinch is found to have a Maxwellian component (temperature 15 eV) and a high energy tail associated with instabilities. Measurements of total radiated power from Reversed field pinches show that radiation is an important source of energy loss only in discharges with peak currents below 50 kA. Neutral atoms leaving the pinch do not represent a significant energy loss.

13315 Local toroidal and poloidal current density measurements in a high-β-tokamak plasma. Carolan, P.G.; Korten, M.; Waidmann, G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik). pp 497-500 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The aim of the TEE compact torus experiment (R=25 cm, a=9.5 cm) is to investigate the equilibrium and stability of a high-β-Tokamak like plasma. The desired β (3 - 10%) is achieved by fast magnetic compression. At present, the field peak is βsub(phi) = 4.5 kG, which is reached in 1,8μs. The plasma is characterized by the parameters Tsub(e) > approximately 40 eV, Tsub(i) approximately 130 eV, nsub(e) > approximately 6 x 10^{13} cm^{-3}, βsub(theta) = 2 -3, Isub(phi) = 20-25 kA, Isub(ω) = 60-80 kA and q = 2 - 3. For the present operating conditions of TEE the energy losses are too rapid to allow for the establishment of a high-β-Tokamak like equilibrium plasma. To study the stability of a high-β-plasma of this type supplementary heating of the present plasma is required to replenish the energy losses. It is hoped to produce a better preionised plasma and so reduce the energy losses associated with the neutrals. Additional heating may be provided by ohmic heating coils and a better confinement by a power crowbar.

13316 Recent experimental results of plasma focus research at Stuttgart. Decker, G.; Pross, G.; Rueckle, B.; Schmidt, H.; Shakhatre, M. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). pp 401-405 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Important factors influencing the operation of a Mather type Plasma focus (geometry, current density distributions, polarity) are investigated. Spatial density distributions and the development of instabilities are determined by a time sequence of interferograms (0.5 ns exposure) taken at the same shot. Their correlation to the neutron and hard X-ray emission is established. An ionization wave caused by accelerated fast deuterons is preceding the axial shock wave and propagating into the disturbed region. From the measured velocity of this ionization wave the maximum energy of the accelerated deuterons can be determined. Preliminary results of a high voltage plasma focus (120 kV) are presented.

13317 Effects of the initial conditions on the achievement of stable equilibria in a belt-pinch experiment. Graffmann, E.; Hoenen, F.; Kaleck, A.; Konen, I.; Schlueter, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik). pp 521-525 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In the high-voltage experiment TENQ the compression phase of a belt-pinch was investigated. At initial electron densities of 3.10^{14} cm^{-3} no instability was observed during this phase. Finally a stable equilibrium - if slow vertical displacements are disregarded - with an axis ratio b/a = 4 is obtained. At initial density of 5.10^{13} cm^{-3}, where mean ion energies of 180 eV could be obtained, instabilities localized in the region of strong curvature give rise to a fast loss of the confined plasma. It is concluded, that also during the compression phase the axis ratio b/a has not to exceed a critical value of about 5.

13318 Ion temperature measurements on the ZT-1 reversed field pinch. Howell, R.B.; Karr, H.J.; Forman, P.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 431-436 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Ion temperatures were measured on the Los Alomos Z-Pinch machine for a range of toroidal currents, forward bias fields, and toroidal current risetimes. The toroidal current has ranged from 30 kA to about 200 kA with corresponding rates of rise from approximately 1.0 X 10^{10} A/s to approximately 2.0 x 10^{12} A/s. A gas mixture of 80% D_2 and 20% He was used to allow Doppler broadening measurements of the He II 486.6 nm line to find the plasma ion temperature. The measurements reported here are for the derated mode with currents up to 120 kA, and rates of rise < approximately 2.0 x 10^{11} A/s.

13319 Experiments on turbulence in plasma focus. Kuriki, K.; Forrest, M.J.; Morgan, P.D.; Peacock, N.J. (UKAEA Research Group, Abingdon. Culham Lab.). pp 395-399 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Light scattering measurements on Plasma Focus indicate that prior to the break-up of the dense pinch the scattered intensity is consistent with a thermal plasma. Following pinch break-up, scattered intensities of up to 3 times thermal have been observed, indicating plasma turbulence. When a pulsed CO_2 laser beam was focused into the pinch, the level of Langmuir wave oscillations, which had been close to thermal, was enhanced by up to a factor of 30.

13320 Experiments on the plasma equilibrium with a closed helical magnetic axis (Asperator-K). Nagao, S.; Watanabe, H.; Koyama, K. (Tohoku Univ., Sendai (Japan). Faculty of Engineering). pp 369-373 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1976).

Experiments are reported on the equilibrium of the plasma column in a small theta pinch with a closed helical magnetic axis, Asperator-K (major radius 36 cm, minor radius of helical glass tube 4 cm and period number 12). In the device is produced a helical plasma column of 12 mm in diameter and with a helical amplitude of 10-20 mm, which is almost as large as that of the magnetic axis of the device. The observed axial current of about 1 kA, which corresponds to the safety factor q equal to 2, can be explained by the transverse magnetic flux measured as a function of the longitudinal flux. The axial currents are varied by the transformer induction in a range from null to 2 kA without the serious loss of the plasma stability.

13321 Observations of soft x-ray emitting plasma structures during the main neutron emission of plasma foci. Rager, J.P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy)). pp 391-394 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Soft x-rays have been observed during the main neutron emission phases in both the Filippov (72 kJ, 32 kV) and Mather (24 kJ, 32 kV) plasma focus assemblies at Frascati. A 10 ns gated soft x-ray image intensifier is used to obtain a sequence of time resolved frames. Electron densities in the emitting zones are evaluated and compared to those deduced from interferometric measurements carried out on similar devices.

13322 Conditions of the existence of 'short circuit' effect for plasma in a conducting cylinder. Zhilinskii, A.P.; Kuteev, B.V. (Leningradskij Politekhnicheskij Inst. (USSR)). *Zh. Tekh. Fiz.;* **45**: No. 10, 2083-2091(Oct 1975). (In Russian).

It has been experimentally established that in a cylindrical container with conducting side and end walls, the phenomenon of short circuit (the Symon effect) is not always realized. The short circuiting of plane end and of side surfaces causes an acceleration of a plasma decay only during the initial stage in a comparatively short time. Characteristic lifetimes during the late stage remain unchanged in this case. In conditions of a stable plasma they correspond to classical values of the plasma decay constant at the ambipolar diffusion of charged particles along and across force lines of a magnetic field. A fundamental change in the nature of the diffusion and a decrease of the plasma lifetime almost by two orders are realized in an instrument in which an end conducting wall for plasma in created with a short cylinder at the end of a solenoid in a sharply nonuniform magnetic field. The data obtained testify to the fact that the short circuit effect takes place in conditions when on boundaries of plasma the possibility of simultaneous flowing of unipolar electron flows along and of ion flows across a magnetic field is assured. The results of the experiments are compared with a theory.

13323 Collisional and anomalous diffusion of a weakly ionized plasma in a cylinder with conducting walls. II. Zhilinskii, A.P.; Kuteev, B.V. (Leningradskij Politekhnicheskij Inst. (USSR)). *Zh. Tekh. Fiz.;* **45**: No. 10, 2092-2089(Oct 1975). (In Russian).

Conditions were investigated when a plasma became instable while decaying in a cylindrical container with conducting walls in uniform mgnetic field H. The destabilizing factors were: the misalighment of the discharge container axis (OZ) with respect to the direction H, and also the takeoff of electron current to a probe or supplying pulse voltage on the probe. To investigate the effect of the misalignment on a diffusion, the cathode end of the experimental instrument was fixed with respect to a solenoid yoke and the anode end was displaced in the plane perpendicular to H at a distance Δx < or approximately 10 mm relative to the adjusted position ($\Delta x = 1$ mm corresponds to an angle α approximately 4'). The instrument was adjusted by the maximum of a critical field Hsub(k). The pressure of helium was 0.1 mm Hg. The magnetic field changed to 3.5 kOe. The plasma was found to be most stable with respect to disturbing factors in magnetic fields where the ion collision frequency was comparable with cyclotron frequency (Ωsub(i)/νsub(ia) approximately 1.5). When the misalignment increased in strong magnetic fields (Ωsub(i)/νsub(i) > 1) a plasma stabilization was observed during some time (up to 100 mcs) in areas near walls. It was also established that at later decay stages the 'short circuit effect' which might be realized near the side walls of the cylinder during the misalignment did not cause a notable increase of the rate of charged particles elimination from the areas.

13324 Investigation of high-current self-compressed discharges in xenon. Azimuthal induction pulse discharge (theta pinch). Andreev, S.I.; Baikov, O.G.; Dashuk, P.N.; Popov, P.G. *Zh. Tekh. Fiz.;* **45**: No. 8, 1735-1744(Aug 1975). (In Russian).

The induction implusing discharge in xenon has been investigated at an initial pressure from 1 to 100 mm Hg, at energies to 10 kj and discharge voltage to 50 kV in cylindrical chambers to 10 cm in diam. It has been found that the initial rate of the plasma focussing is proportional to the discharge voltage and inversely proportional to the square root of the gas density. In the conditions when the shock wave velocity reaches 6 to 10 km/sec., the discharge regime is discovered characterized by an intensively radiating, current-transporting shock wave. The energy balance of the discharge is considered, from which it follows that, as the shock wave velocity and the gas density increase, the part played by the radiation losses becomes much more significant. At an initial pressure in xenon of the order of several millimeters of mercury, there has been observed the plasma temperature of up to 60,000 deg K and the brightness temperature of the order of 20,000 deg K. I has been shown that the ignition voltage for the induction discharge may be determined to a practically sufficient accuracy from the known (from the literature) experimental curves obtained for a high-frequency breakdown.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 13378

13325 (ANL/FPP—77-1, pp 101) **Applied plasma physics.** Boley, C. 1977.

In Fusion power program quarterly progress report, January—March 1977.

Brief descriptions are given of transport theory for Tokamak plasmas and of atomic data for the resonance transitions of the sodium isoelectronic sequence. (MOW)

13326 (COO—2200-9) **Numerical simulations of plasmas with smoothing in phase space and filtering in time. Progress report, October 1, 1976—September 30, 1977.** Denavit, J. (Northwestern Univ., Evanston, Ill. (USA)). 1977. Contract EY-76-S-02-2200. 8p. Dep. NTIS, PC A02/MF A01.

The research is directed toward the development and testing of new numerical methods for particle and hybrid simulation of plasmas and their application to physical problems of current significance to Magnetic Fusion Energy. During the past year, research on the project has been concerned with the following specific problems: (i) Analysis and computer simulations of the dissipative trapped-electron instability in tokamaks. (ii) Computer simulation of field-reversed ion ring stability. (iii) Computer simulations of nonlinear electrostatic wave phenomena.

13327 (IPP—6/156) **2-D fluid calculations of anomalous trapped ion transport in Tokamaks.** Saison, R.; Wimmel, H.K.; Sardei, F. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Mar 1977. 38p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The collisional, nonlinear trapped-fluid equations of Kadomtsev and Pogutse (K.P.) are used as a description of the dissipative trapped-ion modes. The equations are solved numerically in two spatial dimension as an initial-value problem, with due observation of the appropriate boundary conditions, which are derived. Numerical results are given for the resulting anomalous diffusion coefficient D at late times, when the dissipative trapped-ion instability saturates. In terms of appropriate units, D is found to depend, in essence, on one dimensionless parameter only. Examples of the time development D(t) are also given. The numerical values of D (at late times) are generally larger than according to the K.P. formula, and the scaling of D with the equilibrium parameters resembles Bohm scaling. The dependence of the results on the numerical grid and on the initial conditions was also studied. In addition, several analytical results are presented, some of which have been successfully used for testing the numerical code.

13328 (KFTI—76-13) **Magnetic configuration of the spiral current winding with a short pitch.** Demchenko, V.V.; Romanov, S.S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1976. 20p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

A magnetic configuration of a spiral with current is investigated in conditions when the pitch spiral is small. The existence of closed magnetic surfaces with a spatial magnetic axis has been shown and expressions for the turn angle of a magnetic line of force about the spatial magnetic axis have been obtained. With increasing angle of spiral inclination the turn angle of the magnetic axis increases fluently. Resonance phenomena arising in the magnetic configuration under the effect of corrugated magnetic fields have also been studied, when the magnetic axis splits, giving rise to additional axes.

13329 (KIYI—76-11) **Investigation of the stationary-thermonuclear-reaction realization possibility in a tokamak device.** Kolesnichenko, Ya.I.; Reznik, S.N.; Fursa, A.D. (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1976. 12p. (In Russian). Dep. NTIS (US Sales Only), PC A12/MF A01.

The stationary (quasistationary) selfsustaining thermonuclear D-T reaction is shown to be possible in a toroidal device such as 'Tokamak' with large enough plasma radius. The stationary temperature of the plasma can be quite high. Thus when the transport processes are assumed to be neoclassical the temperature of the central part of a plasma colomn of radius approximately 10-200 cm in the stationary state is 70 keV.The stationary temperature distribution is reached spontaneously as a result of the thermal instability development if plasma is preheated to 10 keV. The stationary thermonuclear burning is also possible at lower temperatures if plasma energy balance is controlled.

13330 Studies of a continuous flow pitch. Abas, S.; El-Fayoumi, M.K.K. (University Coll. of North Wales, Bangor (UK)). *Plasma Phys.;* **19**: No. 8, 715-736(Aug 1977).

A steady one-dimensional ideal isentropic flow model for the Continuous Flow Pinch is discussed. In spite of its simplicity the model accounts for the basic features of the Flow Pinch. The necessity of the existence of a shock is shown and the shock position as a function of various parameters is commented upon. Two important parameters in this model are β, the ratio of plasma to magnetic field density, and γ, the ratio of the specific heats. The dependence of the flow parameters on β and γ is discussed. A computer simulation of the Continuous Flow Pinch which utilizes the Focus Code is also presented. The dynamical formation and the structure of the plasma source in front of the central electrode, and the wake shock that develops are resolved.

13331 (ORNL/TM—6035) **Neutron time behavior for deuterium neutral beam injection into a hydrogen plasma in ORMAK.** England, A.C.; Howe, H.C.; Mihalczo, J.T.; Fowler, R.H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

Neutrons were produced by D-D interactions when a 28-keV deuterium beam was coinjected into a hydrogen plasma in the Oak Ridge Tokamak (ORMAK). Fokker-Planck calculations, which correctly predict the time behavior of the neutron rate after beam turnon, show that the majority of the neutrons are from injected particles interacting with previously injected deuterons that have scattered to pitch angles of approximately 60 to 90° while slowing down.

13332 (ORNL/TM—6050) **Numerical calculation of impurity charge state distributions.** Crume, E.C.; Arnurius, D.E. (Oak Ridge National Lab., Tenn. (USA)). Sep 1977. Contract W-7405-ENG-26. 41p. Dep. NTIS, PC A03/MF A01.

The numerical calculation of impurity charge state distributions using the computer program IMPDYN is discussed. The time-dependent corona atomic physics model used in the calculations is reviewed, and general and specific treatments of electron impact ionization and recombination are referenced. The complete program and two examples relating to tokamak plasmas are given on a microfiche so that a user may verify that his version of the program is working properly. In the discussion of the examples, the corona steady-state approximation is shown to have significant defects when the plasma environment, particularly the electron temperature, is changing rapidly.

13333 (ORNL/TM—6065) **Study of possible separable solutions for plasma transport in ohmically heated tokamaks.** Uckan, T. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

The transport problem for an ohmically heated tokamak plasma is investigated analytically with the separation of the variables time, t, and rho = $r^2h(t)$, where r is the space coordinate and h(t) is only a function of time. This investigation examines the circumstances under which these analytical solutions are possible. The time evolution of the current density and temperature profiles is then obtained for a simple plasma model which includes the electric field diffusion and heat conduction losses. Expressions are also given for plasma discharge parameters such as the time evolution of the safety factor, the plasma current, the poloidal flux function, the skin time, the poloidal beta, the transformer flux, and the electron energy lifetime. The results are then applied to a typical size tokamak device.

13334 Thermal conductivity in a partially degenerate electron plasma. Gouedard, C. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Plasmas). *J. Phys., A (London);* **10**: No. 8, L143-L145(Aug 1977).

The dielectric RPA response function is used to evaluate the thermal conductivity of a partially degenerate electron gas in the presence of classical ions, for any temperature.

13335 Single particle trajectories in axisymmetrical electromagnetic fields: application to Tokamaks under runaway regime. Gratreau, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). *Plasma Phys.;* **19**: No. 8, 695-706(Aug 1977).

The dynamics of charged particles in axisymmetrical electromagnetic fields are reviewed. The existence of a magneto-kinetic potential well is emphasized. Applications to conventional and air-cored betatrons with a toroidal field are given. An interpretation of some of the experiments on Tokamaks in the runaway regime is proposed. An improvement for such Tokamaks is suggested.

13336 Ionization equilibrium and radiation losses of molybdenum in a high temperature plasma. *Plasma Phys.;* **19**: No. 7, 587-591(Jul 1977).

The ionization equilibrium and the associated radiation losses of molybdenum have been calculated as a function of the electron temperature. In the 1-2 keV range the computed fractional abundances are supported by a few experimental facts obtained in T.F.R. Tokamak plasmas.

13337 Numerical study of drift-kinetic evolution of collisional plasmas in tori. Beasley, C.O. Jr.; McCune, J.E.; Meier, H.K.; van Rij, W.I. (Oak Ridge National Lab., Tenn. (USA)). *Plasma Phys.;* **19**: No. 7, 593-609(Jul 1977).

Preliminary numerical results for the dynamics of toroidally confined plasmas in the drift-kinetic, Fokker-Planck description are discussed. These solutions were obtained by using the collisional plasma model (CPM). An initial value problem was solved in which collisions and particle dynamics compete in a given magnetic field to set up a quasi-equilibrium. The plasma (guiding center) distribution function and many macroscopic quantities of interest are monitored. Good agreement with corresponding but more approximate theories is obtained over a wide range of collisionality, particularly with regard to the neoclassical particle flux. Confirmation of earlier results for the distribution function is achieved when due account is taken of the differing collisionality of particles with differing energies.

13338 Magnetized plasma kinetic theory. III. Fokker-Planck coefficients for a uniform magnetized plasma. Hassan, M.H.A. (Khartoum Univ. (Sudan)); Watson, C.J.H. *Plasma Phys.;* **19**: No. 7, 627-649(Jul 1977).

The magnetized Balescu-Lenard Collision integral for a multispecies plasma in the form derived by Hassan and Watson (1976) is approximated by ignoring wave effects. The resulting collision integral is put in Fokker-Planck form and most of the integrals occurring in the coefficients are performed analytically. The remaining integral is evaluated approximately in various limits for ion-electron, electron-electron and electron-ion interactions.

13339 Dissipative, forced turbulence in two-dimensional magnetohydrodynamics. Fyfe, D.; Montgomery, D. (National Center for Atmospheric Research, Boulder, Colo. (USA)); Joyce, G. *J. Plasma Phys.;* **17**: No. , p. 369-398(Jun 1977).

The equations of motion for turbulent two-dimensional magnetohydrodynamic flows are solved in the presence of finite viscosity and resistivity, for the case in which external forces (mechanical and/or magnetic) act on the fluid. The goal is to verify the existence of a magnetohydrodynamic dynamo effect which is represented mathematically by a substantial back-transfer of mean square vector potential to the longest allowed Fourier wavelengths. External forces consisting of a random part plus a fraction of the value at the previous time step are employed, after the manner of Lilly for the Navier-Stokes case. The regime explored is that for which the mechanical and magnetic Reynolds numbers are in the region of 100 to 1000. The conclusions are that mechanical forcing terms alone cannot lead to dynamo action, but that dynamo action can result from either magnetic forcing terms or from both mechanical and magnetic forcing terms simultaneously. Most real physical cases seem most accurately modelled by the third situation. The spatial resolution of the 32 x 32 calculation is not adequate to test accurately the predictions of the spectral power laws previously arrived at on the basis of the assumption of simultaneous cascades of energy and vector potential. Some speculations are offered concerning possible relations between turbulent cascades and the 'disruptive instability'.

13340 Effect of fluctuating electric fields on superbanana diffusion of plasma in a stellarator. Voitsenya, V.S.; Voloshko, A.Yu.; Solodovchenko, S.I.; Shtan, A.F. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Phys. Lett., A;* **61**: No. 3, 173-174(2 May 1977).

It is shown that the excitation of electric fields of a wide noise spectrum in the appropriate frequency range results in an approximately 30% increase of the low collisional plasma containment time at the l=3 stellarator Saturn.

13341 Nonlinear singular structures for noncollisional fluids in the phase space. Burgan, J.R.; Gutierrez, J.; Fijalkow, E.; Navet, M.; Feix, M.R. (Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France)). *J. Phys. (Paris), Lett.;* **38**: No. 7, L.161-L.165(1 Apr 1977). (In French).

The solution of the Vlasov-Poisson one dimensional system is studied both for a single repulsive species (beam) and for an electron plasma in presence of a motionless ionic background. An ansatz on the form of the distribution function leads to a solution with a rod structure in phase space. This was already obtained by self-similarity arguments in the beam case. The initial conditions of the rod and treat both beam and plasma problems are generalized. The introduction of the concept of contamination enables the rod to be cut to get rid of non physical boundary conditions but it introduces a time limitation on the validity of the solution for some (or all) particles. As long as particles are not contaminated an invariant can be obtained. Computer simulations support this theory very well.

13342 Magnetic dynamo action in two-dimensional turbulent magneto-hydrodynamics. Fyfe, D.; Joyce, G. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy); Montgomery, D.L. *J. Plasma Phys.;* **17**: 317-335(Apr 1977).

Two-dimensional magnetohydrodynamic turbulence is explored by means of numerical simulation. Previous analytical theory, based on non-dissipative constants of the motion in a truncated Fourier representation, is verified by following the evolution of highly non-equilibrium initial conditions numerically. Dynamo action (conversion of a significant fraction of turbulent kinetic energy into long-wavelength magnetic field energy) is observed. It is conjectured that in the presence of dissipation and external forcing, a dual cascade will be observed for zero-helicity situations. Energy will cascade to higher wavenumbers simultaneously with a cascade of mean square vector potential to lower wavenumbers, leading to an omni-directional magnetic energy spectrum which varies as ksup(-1/3) at lower wavenumbers, simultaneously with a build-up of magnetic excitation at the lowest wavenumber of the system. Equipartition of kinetic and magnetic energies is expected at the highest wavenumbers in the system.

13343 Rigid rotor equilibrium of a strong ion layer. Kapetanakos, C.A.; Golden, J. (Naval Research Lab., Washington, D.C. (USA)); Chu, K.R. *Plasma Phys.;* **19**: No. 4, 387-394(Apr 1977).

The equilibrium properties of a strong, space charge neutral ion layer that is confined radially by an externally applied magnetic field are examined within the framework of the steady-state Vlasov-Maxwell equations. The selected distribution function not only allows finite radial confinement of the gyrating protons, but also is simple enough that explicit, analytic expressions can be obtained for the particle density, current density, magnetic field and the radii of the p-layer, without any a priori assumption about the radial dimensions of the layer. When the ion density is high, thin layer equilibria exist only for small rotational velocities, and for a small range of the conducting wall radius, the frequency of rotation can be considerably greater than the cyclotron frequency corresponding to the externally applied magnetic field.

13344 Basic principles of electron density fluctuations in a plasma. Theimer, O.; Behl, Y.K. (New Mexico State Univ., Las Cruces (USA)); Hicks, W.J. *Plasma Phys.;* **19**: No. 4, 369-379(Apr 1977).

The collective fluctuation spectrum of the electron density in a plasma is calculated by a method which does not utilize a specific kinetic equation, and relies only on the following three very general principles: the linear response of a plasma to a weak electric field, the Nyquist theorem, and the principle of causality in the form of the Hilbert transform relations. A new general principle (Equation 23) is deduced from the preceding ones which relates the random fluctuation spectrum uniquely to the imaginary part of a function G. This function determines most of the important plasma properties such as the electrical conductivity, the permittivity, and the collective fluc-

tuation spectrum. The four principles together allow one to deduce the collective fluctuation spectrum from the random single particle spectrum previously derived by one of the authors. Non-additive combination of Landau damping and collision damping is one of the results.

13345 Generalized elliptic equilibria in the magnetohydrodynamic approximation. Woolley, M.L. (Sussex Univ., Brighton (UK)). *J. Plasma Phys.;* **17**: No. , 259-264(Apr 1977).

A simple class of static equilibria, in the ideally conducting magnetohydrodynamic approximation, is found to include linear systems having surfaces of constant hydrodynamic pressure with a cylindrical topology and elliptic transverse cross-section functionally dependent on an axial co-ordinate. These suggest a possible mode of behaviour for non-axisymmetric toroidal systems and might themselves be realized experimentally as free boundary configurations of a plasma in an applied quadrupole-like magnetic field.

13346 Numerical investigation of the time evolution of impurity concentration in a tokamak. Amano, T. (Osaka Univ., Suita (Japan). Faculty of Engineering); Okamoto, M. *Nippon Seirigaku Zasshi;* **42**: No. 3, 1019-1024(Mar 1977).

Numerical analysis has been made of the time evolution in density profiles of the impurities in a Tokamak. The diffusion and atomic processes of impurities are treated simultaneously. Two different numerical methods were used; the results are in good agreement between the two. Calculations are made in the case of a constant spatial distribution of the plasma. The impurity concentration in the plasma is revealed. The procedure may be useful for analysis of the time evolution of a Tokamak plasma in computer simulation and for the analysis of the impurities by optical measurement.

13347 Coherent transport in a strongly unstable plasma. Sato, T.A. *Comments Plasma Phys. Controlled Fusion;* **2**: No. 6, 185-195(Jan 1977).

The nonlinear transport for lambdasub(z) approximately K^{-1} is examined. In some cases the actual characteristic wavelength lambdasub(z) of drift or flute models is of the order of the characteristic length of the plasma, namely, lambdasub(z) approximately K^{-1}. The diffusion treatment is then no longer valid, and collective or coherent transport must be taken into consideration.

13348 Neoclassical theory of the transport process. Sagdeev, R.Z.; Galeev, A. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 1, 23-28(1977).

The main results of neoclassical theory for particle motion in magnetic traps are discussed. The limitations of the theory are described.

13349 Large-scale flows of collisionless plasmas along the magnetic lines of force: electric fields and currents parallel to the magnetic field, the stress tensor. Hruska, A. (National Research Council of Canada, Ottawa, Ontario. Div. of Physics). *Physica, B, C;* **83**: No. 2, 220-226(Jun 1976).

The standard derivation of plasma equations for large-scale motion by expanding in the particle mass to charge ratio fails if the flow velocity along the magnetic lines of force (B-lines) exceeds a certain limit. Large-scale and fast flows of plasma along B-lines are associated with electric fields and currents with a component parallel to B. Off-diagonal terms in the pressure tensor matrix assume non-zero values dependent on geometry of the B-lines. The plasma equations are reduced to standard equations for large-scale plasma motions if the macroscopic velocity along the B-lines decreases toward the average particle velocity perpendicular to B.

13350 Diffusion processes in high-beta plasmas including neutral gas and impurity effects. Becker, G.; Duechs, D.F. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 547-551 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A three fluid computer model for electrons (e), ions (i) and neutrals (o) has been developed for diffusion processes in a high-beta plasma (belt-pinch). Mainly the influence of neutral hydrogen and oxygen impurities as well as ohmic heating by both toroidal and poloidal currents are investigated.

13351 Numerical studies of the linear theta pinch. Brackbill, J.U.; Menzel, M.T.; Barnes, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 345-349 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Aspects of several physical problems associated with linear theta pinches have been studied using recently developed numerical methods for the solution of the nonlinear equations for time-dependent magnetohydrodynamic flow in two- and three-dimensions. The problems studied include the propagation of end-loss produced rarefaction waves, the flow produced in a proposed injection experiment geometry, and the linear growth and nonlinear saturation of instabilities in rotating plasmas, all in linear geometries. The studies illustrate how numerical computations aid in flow visualization, and how the small amplitude behavior and nonlinear fate of plasmas in unstable equilibria can be connected through the numerical solution of the dynamical equations.

13352 Initial dynamics, equilibrium, and heating of toroidal belt pinches. Chu, C.K.; Lui, H.C.; Reusch, M.F.; Taussig, R.T. (Columbia Univ., New York (USA)). pp 553-556 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The various aspects of the numerical simulation effort at Columbia University on toroidal belt pinches are summarised. These results are directly used in our design and parameter selection for the Columbia Torus I high beta tokamak, initially to be run in the belt pinch mode without a toroidal bias field.

13353 Hybrid-kinetic model for collisionless high-β plasmas. D'Ippolito, D.A. (Maryland Univ., College Park (USA)); Davidson, R.C. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 167-170 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1π75).

A hybrid-kinetic model (Vlasov ions and drift-kinetic electrons) has been developed to study the equilibrium and stability properties of collisionless high-β plasmas. Since the ion orbits may be large in high-density pinch experiments, the ions are described by the exact (unexpanded) Vlasov equation. The electrons are assumed to be strongly magnetized with ω/Ωsub(e) or rsub(Le)/Lsub(perpendicular to) = epsilon << 1, and the electron Vlasov equation is expanded to give a drift-kinetic equation for fsub(e). Complex equilibrium configurations (toroidal geometry, arbitrary cross section, etc.) can be described within the context of the hybrid-kinetic model with considerable flexibility, a feature which is not true in a fully kinetic description. Stability calculations for linear theta-pinch geometry show that the hybrid-kinetic model correct to 0(epsilon) has sufficient physics content to describe implosion stability behavior on the fast time scale ωsub(LH)$^{-1}$ = (Ωsub(e)Ωsub(i))sup(-1/2).

13354 Numerical studies of theta-pinch implosion including classical and anomalous transport processes. Davidson, R.C.; Hui, B.H.; Leiwer, P.C.; Hamasaki, S. (Maryland Univ., College Park (USA)). pp 171-175 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

We report here on two numerical models for studying the implosion dynamics in theta pinches. The first model is an extension and modification of the Liewer and Krall code to include, in addition to turbulent transport, the effects of classical transport (heat conduction, resistive heating, etc.) as well as effects of ionization, neutral-particle diffusion and charge exchange. The second model is a fluid electron Vlasov-ion code developed to study ion dynamics and heating in situations such as collisionless theta-pinch implosions where the ions tend to multistream, thus making a fluid description inadequate.

13355 MHD turbulence models for the reversed field pinch. Gimblett, C.G.; Watkins, M.L. (UKAEA Research Group, Abingdon. Culham Lab.). pp 279-281 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A kinematic model which describes the effect of isotropic, non-mirror symmetric turbulence on a mean magnetic field is used to examine the temporal behaviour of magnetic field in high beta pinch experiments. Solutions to the model can indicate the formation of a steady-state, force-free configuration that corresponds to the state of lowest magnetic energy and the reversal of the toroidal magnetic field at the plasma boundary in accordance with experimental observations on toroidal pinches such as ZETA and HBTX. This model neglects both the dynamic interaction between fluid and field and the associated anisotropy. These effects are examined in a further model.

13356 Analytical computation of self-inductance changes in a plasma focus. Gratton, F.; Vargas, M. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). pp 461-465 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A simple, although only approximate, model for the motion and shape of the current sheath is presented, from which the variable

self-inductance can be computed. The circuit equation can be solved self-consistently with the sheath motion. Results are given by analytic formulae. The method is exemplified numerically for a low energy plasma focus.

13357 Studies of the gas-embedded Z-pinch. Hartman, C.W.; Struve, K.; Eddleman, J.; Munger, R.H.; Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.); Cheng, D.Y. (Santa Clara Univ., Calif. (USA)). pp 313-316 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1976).

Numerical modeling and experimental investigations of the gas-embedded Z-pinch are reported. One dimensional MHD calculations, including ionization, are extended to include α-particle heating effects for very dense pinches. Heating from 10 to 50 keV is dominantly due to α-heating and in consequence the pinch expands radically. Experimental studies of the gas-embedded Z-pinch were conducted using a relativistic electron beam to provide an initial ionized channel. Both pinch and expanding discharge channel modes are observed depending on pressure. The observed growth of helical deformation driven by the kink instability is compared with a nonlinear theory. The theory is found to over-estimate the observed helix radius by roughly a factor of 10.

13358 Decay and profile of the toroidal plasma current in a screw pinch. Hoekzema, J.A. (Association Euratom-FOM, FOM-Institut voor Plasmafysica, Rijnhuizen, Jutphaas, (Netherlands)). pp 541-545 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In a screw pinch the magnetic field, applied at the wall, usually has a pitch that is approximately constant in time. If the low-density plasma outside the main plasma column has a high conductivity, the induced toroidal plasma current density in this region is almost homogeneous for practical q-values. Experimental results show, however, that in the region just in front of the wall this current, if induced at all, decays rapidly. The role of resistivity is demonstrated by comparison with numerical model calculations. If the current density decreases towards the outer wall, the stability and equilibrium properties of the pinch are affected. The stability regions above the Kruskal-Shafranov limit shrink in size. Below this limit the equilibrium shift is increased, but stable equilibrium remains possible for high beta values.

13359 MHD simulation of high-beta tokamaks using flux coordinates. Jardin, S.C.; Chance, M.S.; Greene, J.M.; Grimm, R.C.; Johnson, J.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). pp 129-134 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A time-dependent, explicit, finite-difference program is described which uses the ideal MHD equations to follow the temporal development of a high-beta tokamak. A natural coordinate system, based on the field lines, is adopted so that the anisotropic behavior of a magnetically confined plasma is well represented. The formalism of our other MHD computations is adopted, so that the programs are compatible in the sense that the results of one calculation can serve as input data for another.

13360 Rotating theta-pinches. Kadish, A.; Spies, G.O. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). pp 141-145 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

An attempt is made to explain the mechanism responsible for plasma rotation in straight theta-pinches by using a single fluid MHD model in an idealized theta-pinch geometry. Analysis yields a non-standard system of equation with small Hall term which increases the order of the now singularly perturbed system. Asymptotic analysis further shows that shorting of the electric field at the end plates propagates into the plasma, producing rotation.

13361 Numerical computations for screw-pinch experiments. Lister, G.G. (Association Euratom-FOM, FOM-Instituut voor Plasmafysica, Rijnhuizen, Jutphaas (Netherlands)). pp 341-344 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Numerical solutions to the time-dependent MHD equations have been obtained for parameters appropriate to the SP1CA experiment. The first 10 μsec of the discharge is followed and results obtained are in broad agreement with the experiment. The greatest outstanding problem concerns the detailed treatment of the low-density region surrounding the main pinch after the implosion.

13362 Toroidal equilibria of reversed field pinch. Mohri, A. (UKAEA Research Group, Abingdon. Culham Lab.). pp 307-311 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The toroidal configuration of reversed field pinch with finite β is analytically examined by using a reasonable spatial distribution of the pressure. The condition of field reversal and the shift of the magnetic axis are given as a function of β. Extraordinary magnetic surfaces appear on the major axis side of the torus when the field reversal becomes very large. However, this appearance is excluded in the condition of normal operations. It is again verified that the total fraction of trapped particles is smaller than in the case of tokamak and it decreases with β. At higher value of β, trapped particles on the inside of the torus came out.

13363 Yield enhancement of the plasma focus. Sahlin, H.; Gullickson, R.; McFarland, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). pp 471-475 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A model of the plasma focus for both high and low density mode operation is presented, and employed to develop a semiempirical scaling law that predicts the high density mode yield should scale as the bank energy Esub(b)sup(2,5). For optimum low density mode operation the focus becomes an ultrafast pulsed power source with a fraction f$\rightarrow$1/4 of the bank energy converted into a small diameter high current electron burst and an oppositely directed ion burst.

13364 Numerical approach for finding stable MHD equilibria. Schlueter, A.; Chodura, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 187-191 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

As well known, the question of how to find general 3-dimensional MHD-equilibria is still unsolved. Recently a procedure has been proposed to tackle this problem. It starts from a modified MHD-model: plasma inertia is replaced by a fictitious friction of the plasma against a background medium at rest (the friction force is assumed to be proportional to plasma velocity with a positive definite coefficient). Like in MHD, the motion of the system is constrained by the conservation of mass and of magnetic flux; as a consequence of the friction force, the energy of the system is monotonically reduced until, finally, a MHD-equilibrium state is reached. Moreover, it can be shown that an asymptotic equilibrium of the modified system is in general a stable equilibrium of the original MHD-system. The model equations were solved with an explicit numerical scheme in 1, 2 and 3 dimensions. The model has been used to find axisymmetric equilibria of the screw- and belt-pinch-type and to study the non-linear behavior of unstable modes.

13365 Guiding center plasma stability of the bumpy theta pinch. Schmidt, M.J.; Vahala, G. (College of William and Mary, Williamsburg, Va. (USA). Dept. of Physics). pp 301-305 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In a great many present day as well as future plasma confinement experiments, the Larmor radii (Rsub(L)) of the constituent charged particles are very much less than the dimensions of the experimental apparatus. It is in this limit (Rsub(L) $\rightarrow$ 0) that the guiding center plasma (GCP) equations are of importance. A comparison of the GCP equations with the better understood MHD equations as applied to the diffuse profile bumpy theta pinch is made, concentrating primarily on the MHD spectral theory given by Witzner for the bumpy theta pinch to see how the GCP approximation can modify these results. In particular attention is restricted to oscillatory modes transverse to the magnetic field. These are the modes found to be most MHD unstable.

13366 Tokamak transport at large poloidal beta, considering MHD stability limits. Sigmar, D.J.; Freidberg, J.P. (Massachusetts Inst. of Tech., Cambridge (USA)). pp 135-139 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The effect of β on collisional and anomalous trapped particle diffusion for various equilibria under the constraint of MHD stability is studied: 1. It is demonstrated that at βsub(p) approximately epsilon^{-1} the strong Shafranov shift results in a reduction of the banana width and thus of banana diffusion. 2. The maximum J properties of certain high β equilibria with respect to their stabilizating influence on the interchange trapped particle mode is investigated. The underlying equilibria are characterized by β, the safety

factor q at the plasma boundary and the shape of the toroidal current density profile.

13367 Electron-electron bremsstrahlung in a non-equilibrium plasma. Kvasnica, J. (Karlova Universita, Prague (Czechoslovakia). Fakulta Matematicko-Fyzikalni). *Czech. J. Phys.;* **26**: No. 12, 1355-1357(1976).

Electron-electron bremsstrahlung in a weakly ionized uniform non-equilibrium plasma is investigated. The respective problem is solved analytically for two initial electron distributions: Maxwellian with temperature T_0, and delta distribution. In the case of the initial Maxwellian distribution the radiation intensity is proportional to THETAsup(3/2), where THETA=T+(T0-T)esup(-s), s=2mν1t/M, ν_1 is the momentum transfer frequency, and the other symbols are standard. In the case of the initial delta distribution the radiation intensity is proportional to [1-esup(-s)]sup(3/2). The proportionality factors are known, and are expressed in terms of mathematical and physical constants.

13368 Three-dimensional quasilinear relaxation. Ivanov, A.A.; Soboleva, T.K.; Yushmanov, P.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Zh. Eksp. Teor. Fiz.;* **69**: No. 6, 2023-2041(Dec 1975). (In Russian).

The problem of the dynamics of electron-beam relaxation in a plasma is solved. An analytic solution to the three-dimensional quasilinear equations is found. A numerical simulation of the nonlinear phase of the electron beam-plasma interaction process in the two-dimensional case is carried out. The results of the numerical and analytic solutions coincide. The mechanism of beam-electron capture by the field of the mirror machine is explained.

13369 Bremsstrahlung in non-equilibrium plasma. Akopyan, A.V.; Tsytovich, V.N. (AN Armyanskoj SSR, Erevan. Inst. Radiofiziki i Ehlektroniki; AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* **1**: No. 4, 673-683(Jul 1975). (In Russian).

The process of bremsstrahlung in non-equilibirium plasma is considered in the paper. It is shown that unlike the vacuum there are in plasma two types of bremsstrahlung occuring due to the transformation of virtual electromagnetic quanta, arising in collisions of charged particles, into real ones: Compton radiation and nonlinear radiation. In a quasiclassical limit matrix elements are obtained with the allowance for both new processes of bremsstrahlung and usual processes of bremsstrahlung modified by screening virtual quanta fields by plasma. The calculations are suitable for particles with arbitrary velocities, in particular, for superrelativistic and nonrelativistic particles. The rules are given for calculating the matrix elements of bremsstrahlung in plasma according to corresponding diagrams.

13370 Properties and solutions of the steady-state neoclassical transport equations. Conn, R.W.; Emmert, G.A. (Univ of Wis, Madison). *Nucl. Fusion;* **14**: No. 6, 805-808(Dec 1974).

Some results on the properties and solutions of the steady-state form of the neoclassical transport equations are presented for regimes of interest to feasibility experiments and reactors. An analytical solution is obtained for the special case dT/dr=O. For dT/drdoes not equalO, an analytic solution is found for the particle density n(r) in terms of the current j(r) and the temperature T(r). For a prescribed j(r), a single differential equation remains to find the temperature profile. The numerical results suggest that neoclassical scaling does not admit self-sustained fusion plasma operation except in plasmas of uninterestingly small sizes. 17 refs.

13371 Clumps and the problem of anomalous resistivity. Engelmann, F.; Morrone, T. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 3, 75-79(1972).

A review is given of the problems of anomalous transport phenomena, and in particular anomalous resistivity, which arise in plasmas due to the presence of collective interactions.

13372 Nonneutral plasmas. Trivelpiece, A.W. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 2, 57-62(1972).

The plasma physics of nonneutral plasmas is now being studied more intensively as a result of several experimental programs. A few of the interesting problems and results of plasma physics research are summarised.

PLASMA PRODUCTION

13373 Investigation of a dense plasma flow produced by a conic electrode source. El-Menshawy, M.F.; Nofal, E.E.; El-Masry, M.A.; El-Gwaily, M.S.; Volkov, Ja. (Cairo High Institute of Technology, Cairo, Egypt). *Physica, B, C;* **82**: No. 2, 418-423(Apr 1976).

Detailed measurements of the temporal and axial distribution of a hydrogen plasma flow (plasma density approximately 10^{17} cm^{-3}, electron temperature kTsub(e)=4 eV) generated by a conic electrode source (1.5 kJ, 10 kV, 30 μF) are reported. The effect of a longitudinal magnetic field on the flow velocity and the change in the flow-head part composition have been investigated. A shock-wave front formed in the discharge tube at X>=30 cm from the electrode was also studied, and parameters of the plasma which appear in the discharge tube under the influence of fast electrons and discharge emission have been measured.

13374 Production of shock heated weakly compressed high temperature plasmas in the high voltage belt pinch. Soeldner, F.; Steuer, K.-H. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 527-530 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The production of high temperature weakly compressed plasmas is investigated in the 250 kV Belt Pinch experiment. Density, electron and ion temperatures are measured by laser light scattering and neutron yield. At an initial density of 3 x 10^{13} cm^{-3} the neutron flux yields an ion temperature of 2 keV in agreement with the free particle model of shock compression. The electron temperature on axis, however, remains relatively low. The density compression ratio is about 3.

PLASMA INSTABILITIES

13375 (IPP—III/32) Local, ideal and resistive stability in tokamaks with noncircular cross section. Green, B.J.; Zehrfeld, H.P. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Oct 1976. 25p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Recently, the conditions for stability of an arbitrarily shaped, finite pressure toroidal plasma against localized ideal and resistive modes were presented. The characteristic time scale for local instability with respect to ideal modes is small compared with that for resistive modes so that an investigation of ideal local stability is a prerequisite for an assessment of nonideal local stability. Here we consider the stability of a particular class of noncircular cross-section tokamak equilibria with respect to such modes. The equilibria are described analytically so that no ordering or expansion procedure is necessary, and both ideal and resistive stability is investigated over the whole plasma region. The effects of plasma shape (vertical elongation and triangularity), as well as aspect-ratio are investigated and particular reference is made to next generation tokamak designs (e.g. JET).

13376 (KFTI—75-8) Interaction of modulated flow with plasma in external magnetic field. Kitsenko, A.V.; Panchenko, V.I. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1975. 22p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The interaction of modulated currents of charged particles with a magneto-active plasma is studied. The distribution function of the current particles is a periodic function of time and the coordinate z, measured along the magnetic field axis. It is shown that in this system effective excitations of potential plasma oscillations are not only possible under the conditions of beam resonances but also under conditions of parametric and beam-parametric resonances. Parametric excitation of high-frequency (electronic) plasma oscillations and also of low-frequency oscillations with frequencies lower or in the order of plasma ionic frequencies are considered. The conditions for parametric instabilities are determined and the increments of the oscillations are obtained. The investigated mechanism for the coupling between the high-frequency and low-frequency plasma oscillations is used to explain phenomena observed in some experiments.

13377 (KFTI—75-26) Kinetic theory of modulated electron flow oscillations. Pasynok, A.I.; Repalov, N.S. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only), PC A02/MF A01.

The kinetic theory of oscillations of an electric current propagating in a wave field which comes from a source at one side is developed. It is shown that the termal motion of the particles changes the increment of the parametric instability relative to the case of a "cold" current, and under definite conditions can even suppress it completely. The threshold value for the electric field of the modulating wave and the minimum frequency, below which the instability does not develop, are given. The oscillations spectrum in the beam is completely determined by the reciprocal phase velocity distributions of the wave and the particles. A relation between the amplitudes of single components of the oscillations is found for several special cases, which differ in the velocity distribution function of the particles.

13378 (PPPL—1382) Numerical simulations of collisionless drift instabilities for low-density plasmas. Lee, W.W.; Yau, Y.Y.K.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1977. Contract EY-76-C-02-3073. 47p. Dep. NTIS, PC A03/MF A01.

Nonlinear behavior of the collisionless drift instabilities are studied for the universal and current driven modes by means of electrostatic particle simulations in two-and-a-half dimensions. Real-

istic mass ratios of the electrons to the ions are used in the simulations, where the guiding-center approximation for the electrons and the exact dynamics for the ions are employed. Several nonlinear effects including the quasilinear diffusion of the particle density, the frequency shift due to the ambipolar field, the mode competition among the unstable waves, and the quasilinear diffusion in the velocity space are found to be the dominant mechanisms for the saturation. The stabilization of the collisionless drift instabilities by the magnetic shear has also been studied.

13379 (ERDA-tr—311) **Self-stabilization of a high pressure plasma in toroidal containers with an arbitrary shape for the magnetic axis.** Aburdzhaniya, Kh.D.; Mikhilovskii, A.B. Aug 1977. Translation of Samostabilizatsia plazmy bol'shovo davleniya v toroidal'nykh lovushkakh s proizvol'noi formoi magnitnoi osi. 26p. Dep. NTIS, PC A03/MF A01.

A stability criterion was obtained for a high pressure plasma in toroidal magnetic enclosures with a circular cross section, and with an arbitrary magnetic axis. This criterion is applied in an analysis of the stability of certain actual systems. It is shown that, in these systems, a self-stabilization effect occurs along with increasing pressure, an effect which was originally predicted by Mikhailovskii and Shafranov for a model of a spiral column.

13380 (ERDA-tr—312) **Induced oscillation instabilities and their role in tokamaks with injected neutral particles.** Mazur, V.A.; Mikhailovskii, A.B.; Frenkel', A.L.; Shukhman, I.G. Aug 1977. Translation of Neustoichivosti nesobstvennykh kolebanii i ikh rol' v probleme tokamaka s inzhektsiei neitralov. 35p. Dep. NTIS, PC A03/MF A01.

Instabilities related to the buildup of induced oscillations in an inhomogeneous plasma were studied. The conclusion is that such instabilities under actual conditions may play a more important role than the instabilities which have usually been studied, and which are related to natural oscillations. The general concepts of induced oscillation instabilities are applied to a tokamak injected with neutral particles. It is concluded that because of the presence of instabilities related to the build-up of induced oscillations the plasma in the tokamak should be more unstable than has been predicted by the work of Rosenbluth and Rutherford.

13381 (ERDA-tr—313) **Bounce effects in the instability theory of trapped alpha particles in the tokamak reactor.** Kaladze, T.D.; Mikhailovskii, A.B. Aug 1977. Translation of Bauns-effekty v teorii neustoichivosti zapertykh al'fa-chastits b reaktore-tokamake. 20p. Dep. NTIS, PC A02/MF A01.

A theoretical investigation was made of the role of bounce resonances during the cyclotron build-up of high-speed magneto-acoustic waves with trapped alpha particles in the tokamak reactor. It is shown that bounce resonances can lead to an additional increase in the incremental growth of high-speed magneto-acoustical waves in an amount on the order of 0.5 (epsilon ω/sub Bs//ω/sub b/)/sup 1/3/, where ω/sub BS/ is the alpha particle cyclotron frequency averaged over the magnetic surface, ω/sub b/ is the alpha particle bounce frequency, and epsilon is the ratio of the smaller radius of the tokamak to the larger.

13382 (ERDA-tr—314) **Tokamak impurity instabilities.** Mikhailovskii, A.B.; Shukhman, I.G. Aug 1977. Translation of O primesnykh neustoichivostyakh v tokamake. 13p. Dep. NTIS, PC A02/MF A01.

Tokamak impurity instabilities are studied. Two types due to the presence of trapped ions are studied. It is shown that these instabilities are slightly sensitive to shear, and therefore they should be of interest in the problem of the dynamics of impurities in the tokamak.

13383 Linear and nonlinear ideal MHD codes - V103. Hicks, H.R.; Wooten, J.W. (Oak Ridge National Lab., Tenn. (USA)). *Comput. Phys. Commun.;* **13**: No. 2, 117-135(Jul 1977).

The linearized ideal MHD equations are advanced in time. Given an unstable MHD equilibrium, the result is the largest growth rate and the corresponding eigenmode. Given an MHD configuration, the result is the evolution of that configuration. The geometry is a rectangular cylinder with conducting walls and periodic on the ends. An explicit leap-frog time advancement scheme is used on a cartesian grid. The finite difference scheme is space and time centered. Eventually, the fastest growing eigenmode dominates. Only large scale instabilities can be well represented on the finite difference grid. Lower growth rates may be missed due to faster growing numerical instabilities. The user should realize that large areas of parameter space have not been tested.

13384 Stability of cylindrical rotating plasmas to axisymmetric electrostatic perturbations. Barston, E.M. (Illinois Univ., Chicago (USA)). *J. Plasma Phys.;* **17**: No. , p. 409-418(Jun 1977).

Necessary and sufficient conditions for the exponential stability of an N-component, warm or cold, rotating cylindrical plasma to axisymmetric electrostatic perturbations are obtained. The plasma is immersed in an axial magnetic field $B_0(r)$, where r is the radial coordinate and the equilibrium quantities are permitted to be arbitrary functions of r consistent with the O-order equations. The maximal growth rate of an unstable system is shown to be determined by a maximum principle.

13385 Cyclotron instabilities of a magnetized electron plasma with anisotropic temperatures. Chiuderi, C. (Osservatorio Astrofisico di Arcetri, Florence (Italy)); Einaudi, G.; Giachetti, R. *J. Plasma Phys.;* **17**: p. 453-465(Jun 1977).

The dispersion relation for an electron plasma in a magnetic field is investigated for a bi-Maxwellian distribution function. A new set of solutions for non-perpendicular propagation is found. The linear growth rates are computed and the instability regions in the (k, cos theta) plane are determined. An approximate analytical treatment of the problem is also given for certain ranges of the parameters.

13386 Decay instability at the ion-ion hybrid resonance. Bujarbarua, S.; Sarya, Y.; Sen, A. (Physical Research Lab., Ahmedabad (India)). *Plasma Phys.;* **19**: No. 5, 479-489(May 1977).

The parametric decay of a large amplitude a.c. field oscillating near the ion-ion hybrid frequency is studied in a homogeneous two ion-species plasma. Two different decay modes are considered: (i) a low frequency ion acoustic wave propagating parallel to the ambient magnetic field and (ii) a 'cold' ion-Bernstein mode propagating almost perpendicular to the magnetic field. A third possibility (of decay into two ion-ion hybrid modes) is also investigated and estimates of threshold powers and growth rates are discussed in each instance.

13387 Excitation of parametric instabilities by electron cyclotron waves in a plasma column. Scharer, J.E.; Mitzlaff, J.E. (Wisconsin Univ., Madison (USA). Dept. of Electrical Engineering). *Plasma Phys.;* **19**: No. 5, 413-422(May 1977).

Experimental results are presented illustrating parametric instabilities with thresholds as low as a fraction of a watt. Two types of instabilities are observed under different plasma conditions. The type I instability has a broad sideband below the pump and a corresponding low frequency acoustic component. The type II instability occurs at higher neutral pressure, where a 30% dip in density on the column axis is created and has an upper sideband with harmonic structure and no observable low frequency components. Wavelength measurements of each wave components are made to compare with parametric theory. The time domain evolution of the sidebands in the form of an rf burst is observed and discussed.

13388 Suppression of transverse Kelvin-Helmholtz instability by lower hybrid turbulence. Sinha, M.; Sundaram, A.K. (Physical Research Lab., Ahmedabad (India)). *Plasma Phys.;* **19**: No. 5, 407-412(May 1977).

The effect of lower hybrid turbulence on the development of transverse Kelvin-Helmholtz mode for certain limiting cases is investigated. It is shown that the turbulent effects can suppress this mode depending on the proper choice of K parallel to where k parallel to is finite wave number along the magnetic field. The results of this investigation are relevant to Q-machine and auroral sheet plasmas.

13389 Finite amplitude E x B oscillations in bounded plasmas. Holter, O. (Oslo Univ. (Norway). Fysisk Institutt). *J. Plasma Phys.;* **17**: No. , p. 233-249(Apr 1977).

A semi-infinite plasma slab with a density gradient and an externally applied electric field normal to an applied magnetic field is considered. Stable finite amplitude density and potential oscillations are investigated for parameters favourable for the E x B instability. Explicit expressions for the oscillation amplitudes, frequency, and wavelength are derived in the limit of a weak density gradient. The calculations are performed with a closed set of zero and first harmonic equations. It is shown that second harmonic contributions are small in the case considered.

13390 Electrothermal instabilities in a Hall accelerator. Lomas, P.J.; Kilkenny, J.D. (Imperial Coll. of Science and Technology, London (UK)). *Plasma Phys.;* **19**: No. 4, 329-341(Apr 1977).

Measurements are presented showing that current conduction in a high current density Hall accelerator discharge is dominated in the early stages by a single density streamer (a spoke), and later by fast approximately 5 MHz fluctuations. Linear electrothermal theory is extended and is used to identify these modes as an ionisation wave in a molecular plasma and a fast thermal mode in an atomic plasma respectively. A two dimensional time dependent fluid model of the plasma successfully describes further details of the early stages, and shows the effect of ion motion.

13391 Marginal stability analysis. A simpler approach to anomalous transport in plasmas. Manheimer, W.; Boris, J.P. *Comments Plasma Phys. Controlled Fusion;* **3**: No. 1, 15-24(Apr 1977).

It is shown that an unstable plasma evolves towards a marginally stable state. From the knowledge that the plasma is marginally stable, profiles, transport coefficients and turbulence levels can be calculated quite accurately.

13392 Finite geometry effect on the interaction of a hot beam with a plasma. Shoucri, M.M.; Gagne, R.R.J. (Laval Univ., Quebec City (Canada). Dept. of Electrical Engineering). *J. Plasma Phys.;* **17**: No. , 139-146(Apr 1977).

The effect of finite geometry on the interaction of a hot low-density beam with a uniform plasma filling a circular waveguide is studied. An expression is derived for the growth rate of the instabilities developing at the harmonic of the beam gyrofrequency, taking the finite beam gyroradius into account. The calculations are done in the quasistatic approximation.

13393 Kinetic modulational instability of upper-hybrid turbulence. Shukla, P.K.; Yu, M.Y.; Tagare, S.G. (Bochum Univ. (Germany, F.R.). Inst. fuer Theoretische Physik). *Z. Naturforsch., a;* **32**: No. 3, . 335-336(Mar 1977).

It is shown that a plasma containing randomly distributed non-interacting upper-hybrid waves can become unstable against ion quasi-modes. The growth rate of the instability is presented.

13394 Asymptotic expansion of nonlinear unstable collisional drift wave. Hatori, T.; Terashima, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Nippon Seirigaku Zasshi;* **42**: No. 3, 1010-1018(Mar 1977).

Nonlinear evolution equation for the collisional drift wave is obtained in a slab model based on the two fluid equations where the ion inertia, finite gyroradius and viscosity are included. A systematic expansion is introduced by taking epsilon=/k/l as a smallness parameter where k is the degree of density gradient and l is the linear scale of the slab along the density gradient. A set of the model equations is proposed to describe the evolution of the nonlinear drift wave.

13395 Magnetic viscosity and the Rayleigh-Taylor instability of a rotating plasma. Ariel, P.D. (Malaviya Regional Engineering Coll., Jaipur (India)). *Nuovo Cim., B;* **34**: No. 1, 34-46(11 Jul 1976).

The character of equilibrium of a rotating plasma having a variable density along the direction of the gravitational field is investigated taking into account the finiteness of the Larmor radius of the ions. The direction of rotation is chosen along the direction of the magnetic field and transverse to that of the gravitational field. Only the 'worst' modes are considered. It is found that the plasma having negative density gradient in the upward direction remains stable with or without magnetic viscosity and rotation taken separately or together. However, for a plasma having positive density gradient the stratification is stable either for short wavelengths or for long wavelengths of the disturbance owing to the predominance of the effects of FLR or rotation respectively. The over-stability takes place in an intermediate wavelength range in which neither effect is sufficiently strong to impart stability to the system.

13396 Collisional effects on the drift-cyclotron instability. Shukla, P.K.; Yu, M.Y. (Bochum Univ. (Germany, F.R.). Inst. fuer Theoretische Physik); Ong, R.S.B. (Michigan Univ., Ann Arbor (USA)). *Physica, B, C;* **83**: No. 2, 237-240(Jun 1976).

The drift-cyclotron instability in a weakly collisional plasma is considered including temperature perturbations. Collisions are described by a model Fokker-Planck equation. The growth rate of the instability is obtained analytically.

13397 Nonlocal analysis of cross-field instabilities in theta-pinch plasmas. Batchelor, D.B.; Davidson, R.C. (Maryland Univ., College Park (USA)); Gladd, N.T. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 155-159 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The derivation of a fully kinetic, nonlocal, matrix dispersion equation is outlined for electrostatic perturbations about a spatially nonuniform cylindrical plasma equilibrium. This analysis provides a rigorous and tractable formalism to examine kinetic stability properties in circumstances where the mode structure is nonlocalized. In addition, it provides a natural framework to rigorously justify the local approximation in circumstances where a local analysis is applicable. Also discussed is the numerical solution of the radial eigenvalue equation obtained within the framework of a macroscopic two-fluid description of theta-pinch plasmas with Vsub(E) >> vsub(i), where Vsub(E) is the equilibrium E tilde x B tilde drift velocity, and vsub(i) is the ion thermal velocity. It is shown that local and nonlocal theories are in excellent agreement (with respect to maximum growth rate, corresponding l value, and radius of localization) for the fastest growing mode in the system.

13398 Experiments in the Lausanne belt pinch. Bighel, L.; Hofmann, F. (Ecole Polytechnique Federale, Lausanne (Switzerland)). pp 507-512 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

At Lausanne a small belt pinch device has recently been constructed in order to study the stability of this configuration at relatively high temperature. The first measurements in this device (3) have shown that: 1) plasma temperatures, k(Tsub(e) + Tsub(i)), of over 100 eV can be reached, 2) the duration of stable confinement is inversely proportional to the filling pressure and varies between 20 and 40 μs, and 3) that the radial equilibrium can be accurately controlled by varying the diameter of a conducting shell placed around the circumference of the torus. In the present paper we report on new measurements in the Lausanne Belt Pinch. The emphasis is placed on temperature and density measurements by means of Thomson scattering.

13399 Plasma behaviour in straight and helical theta-pinches with low compression ratio. Bogen, P.; Dietz, K.J.; Pospieszczyk, A. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Plasmaphysik). pp 197-201 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

For the wall stabilization of the plasma in a high-beta stellarator low compression ratios and high beta values are required. The production of such plasmas and their behaviour during the quasistationary phase have been studied in straight and helical theta-pinches (E = 350 V/cm, d = 30 cm, L = 7 m, $p_0 = 10^{-3}$ Torr D_2). In the straight geometry pinches with initial densities of nsub(e1) = 0.5, 1.5, and $3.0.10^{13}$ cm^{-3} have been investigated. Only at the latter value of nsub(e1) the β-value remained above 0.6 for more than 10μs. Then a compression ratio < 10 has been found. Depending on the initial degree of ionization energy losses were large, which indicates that the losses are due to fast charge exchange neutrals. In the helical configuration (l = 1) obtained with a shaped coil, a similar behaviour of the β-value and of the compression ratio has been observed.

13400 Time-dependent calculations of equilibrium and stability problems in scyllac and tokamak geometries. Brackbill, J.U.; Barnes, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 111-116 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In preparation for a study of the equilibrium and stability properties of Scyllac, a sequence of problems have been studied by numerically solving the MHD equations in three dimensions. Among these are computations of the dynamics of nonequilibrium plasmas in toroidal theta pinches and high beta tokamaks, which illustrate what happens when there is no equilibrium as well as the approach to equilibrium when one exists. The evolution of Kruskal-Shafranov modes in a defuse screw pinch has also been computed from small amplitude to its final nonlinear state. The application of the same method to Scyllac will be shown.

13401 Experiments on programmed and naturally relaxing RFP configurations. Buffa, A.; Costa, S.; Nalesso, G.F.; Malesani, G. (Centro di Studio sui gas Ionizzati, CNR-Universita di Padova, (Italy)). pp 261-265 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Experiments on R.F.P. produced by full programming or natural relaxation of stabilized Z-pinches have been done in Padua. Reference is made to some new experiments done in order to understand the setting-up and decaying phase of such plasmas, varying parameters like Isub(z max), Bsub(zo) and filling pressure. The dependence of 'self reversal' on THETA (=Bsub(theta) (Rsub(q))/<Bsub(z)>) is also studied, as well as the correlation between the reversal and the associated growth of an helical kink instability, so far detected. For fully programmed R.F.P. plasmas we refer about the range of parameters in which experimentally stable configurations are observed.

13402 Dynamic stabilization of instabilities in a toroidal pinch discharge (TDSX). Butt, E.P.; Firth, L. (UKAEA Research Group, Abingdon. Culham Lab.). pp 245-248 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Experiments on a quartz torus (r = 4.8 cm, R = 30 cm) at plasma currents of up to 80 kA and line densities greater than 10^{17} sup(e)/cm show that an oscillating toroidal field approximately 35 m Tesla rms has a marked stabilising effect on a pinch discharge.

13403 New results from Zeta. Butt, E.P.; Newton, A.A. (UKAEA Research Group, Abingdon. Culham Lab.). pp 425-429 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Previously reported results obtained from Zeta at current approaching 1 MA, with rise times varied by a factor of 3 and with sustained current pulses of 0.02 sec total duration show that stable pinches are readily obtained in these conditions.

13404 Scyllac feedback stabilization experiments. Cantrell, E.L.; Ellis, W.R.; Freeman, B.L.; Gribble, R.F.; Gutscher, W.D.; Johnson, K.J.; Kutac, K.F.; Miller, G.; Quinn, W.E. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 93-98 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

For feedback stabilization experiments the magnetic field in a 120° sector of the Scyllac torus has been lowered to 17 kG, and the plasma parameters adjusted accordingly to reduce the m = 1 instability growth rates to values which are compatible with the response time of the feedback system. Initial plasma studies have been completed and compared with MHD sharp-boundary theory. Studies of the effectiveness of l = 0 and l = 2 feedback fields are reported. Modifications of the Scyllac feedback stabilization system have resulted in improved reliability, decreased response times, and increased output currents.

13405 Review of toroidal theta-pinch theory. Davidson, R.C.; Freidberg, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 13-38 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A review is given of the basic theoretical ideas which describe the evolution of the Scyllac program. Included is a current status report of MHD and microstability theory as applied to the Scyllac configuration.

13406 Post-implosion anomalous transport associated with the lower-hybrid drift instability. Davidson, R.C.; Gerwin, R.A.; Gladd, N.T.; Howell, R.B. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 161-165 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The immediate post-implosion phase of the ZT-1 toroidal pinch experiment is characterized by an anomalously high resistivity so that the average density and magnetic field profiles distort from an MHD-stable configuration to a regime where plasma confinement is lost, probably through an m = 1 kink instability. Moreover, linear theta-pinch experiments during the late stages of imposition often exhibit considerably more diffuse magnetic field profiles than predicted by existing fluid-numerical studies. The experimental results strongly suggest that substantial anomalous resistivity persists even in the low-drift-velocity regime Vsub(E) approximately < vsub(i). An extensive survey of microinstabilities for parameters appropriate to the post-implosion phase of high-density pinches has identified the lower-hybrid-drift instability as the most likely candidate for producing significant anomalous transport. The linear stability behavior and anomalous transport properties associated with this instability are examined assuming flute-like perturbations with k tilde . B tilde $_0$ = 0.

13407 Equilibrium and stability of a diffuse high-beta tokamak. Freidberg, J.P. (Los Alamos Scientific Lab., N.Mex. (USA)); Goedbloed, J.P. pp 117-121 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A study is made of the equilibrium and stability of an axially symmetric diffuse plasma column of circular cross section (radius a, normalized to 1) surrounded by a circular conducting wall (radius b), for which is developed a numerical code which is accurate and fast enough to permit a complete scan of parameter space. this has been accomplished by exploiting the high-beta Tokamak expansion and by the use of a convenient coordinate system.

13408 Plasma instability in the belt-pinch at higher temperatures. Gruber, O.; Wilhelm, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 513-515 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1976).

In the first experiments on Belt-Pinch II, stable operation has been shown for about 20 MHD growth-times at critical q-values near 3 that are comparable to those for low β circular Tokamaks. By reducing the initial density from 5 to 2 mTorr deuterium, the plasma temperature has been increased to about 50 eV at an average density of about 2/3 X 10^{14} cm^{-3}. Under these conditions, the plasma again was found to be stable during a high-beta phase between 70 to 100 μs, corresponding to an enhanced stable plasma confinement for about 40 MHD-growth times.

13409 Stability and diffusion of the ZT-1 reversed-field pinch. Haberstich, A.; Baker, D.A.; Dimarco, J.N.; Mann, L.W.; Ortolani, S. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 249-253 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The ZT-1 reverse-field pinch experiment has been operated in the so-called derated mode at peak toroidal currents of 40 to 110 kA with initial rates of rises of 60 to 200 kA/μs and filling pressures ranging from 8 to 120 mTorr. The experiments reported here were aimed at establishing the effect of diffusion on magnetic field programming and MHD stability. Some of these studies have been extended to a new derated mode of operation with matched risetimes of the applied poloidal and toroidal fields. The Mercier criterion of stability has been computed for certain toroidal configurations.

13410 Numerical simulation of the lower hybrid drift instability. Hewitt, D.W.; Winske, D. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 177-181 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Particle simulations of strongly inhomogeneous plasma phenomena that model theta-pinch behavior in the implosion and post-implosion phases have been performed using an inhomogeneous self-consistent Vlasov equilibrium as an initial state. In the hot ion regime a strong flute instability has been observed, whose properties agree well with those predicted by the linear and nonlinear theory of the lower-hybrid-drift instability.

13411 Experiments on high beta tokamak with small aspect ratio. Hirano, K.I.; Kitagawa, S.; Mimura, M.; Kita, Y.; Ohi, M. (Nagoya Univ. (Japan). Inst. of Plasma Physics). pp 501-505 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The STP (rsub(w) = 10cm, R = 25 cm, Bsub(t) = 9.3kG) has been operated to test high beta tokamak configurations. The main purpose of the STP project is to find stable operations of a tokamak configuration around a density of about $10^{15}/cm^3$. Various scaling laws which have already been established in usual tokamak experiments indicate that high density operation has advantages in trying to fulfil the Lawson criterion. the observation of a large n=1 toroidal mode is described in this report. The appearance of m=2 modes is explained neither by the theory of straight cylindrical plasma nor by that of low-beta, weak toroidal curvature. For its explanation, toroidicity and high-beta should be taken into account. The theory of Freidberg and Haas explains the observations at least qualitatively. The main purpose of this report is to clarify how the plasma is deformed and breaks itself up.

13412 Dynamic stabilization of the m=1 mode on a Z-discharge. Hotta, E.; Shimada, R.; Yamamoto, K.; Hayashi, I. (Tokyo Inst. of Tech. (Japan)). pp 239-243 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Dynamic stabilization of the m=1 mode on a Z-discharge was studied experimentally. The HF current was generated by a newly designed and developed RF generator. Although the quasi-stationary axial current considerably exceeded the Kruskal-Shafranov limit, the growth rate of the m=1 mode was considerably reduced during the existence of the HF axial plasma current.

13413 Investigations of the m = 2 mode on high-beta-stellarator ISART1-B. Kaufmann, M.; Minko, L.; Neuhauser, J.; Rohr, H.; Schramm, G. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). pp 105-109 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Collision-dominated plasma experiments on the ISAR T1-B high-beta stellarator are reported. Instabilities appear at the m >= 2 mode as predicted by MHD theory, but several points need to be resolved still before a satisfactory agreement of theory and experiment is attained. Finite gyro radius effects in the collision-dominated plasma regime have also to be determined.

13414 Stability analysis of sharp-boundary Vlasov-fluid screw-pinch equilibria. Lewis, H.R.; Turner, L. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 183-186 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The Vlasov-fluid model, as proposed by Freidberg, is being used to study the linear stability of sharp-boundary screw pinches numerically. the numerical method appears to work well, and some preliminary results are reported here. The sharp-boundary calcula-

tion is useful for gaining insight and for comparing with known MHD results. We expect to extend the calculation to include diffuse profiles in the future.

13415 Dynamic model of gross plasma motion in Scyllac. Miller, G. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 227-231 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Plasma confinement in a high beta stellarator such as Scyllac is ended by an unstable long wavelength m=1 motion of the plasma to the discharge tube wall. Such behavior has now been observed in several experiments and is considered well understood theoretically on the basis of the sharp boundary ideal MHD model. However the standard theoretical approach using the energy principle offers little physical insight, and sheds no light on the process by which the plasma reaches an equilibrium configuration starting from the initial conditions created by the theta pinch implosion. It was the purpose of this work to find a more complete explanation of the observed plasma behavior in Scyllac and to apply this to the design of a feedback stabilized experiment. Some general consideration is also given to dynamic stabilization.

13416 Effect of magnetic forces on high beta plasma columns. Newton, A.A.; Wootton, A.J. (UKAEA Research Group, Abingdon. Culham Lab.). pp 233-237 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Local perturbing magnetic fields are used to excite motion of a 3.5 m long plasma column. A screw pinch, showing gross instability, is perturbed by a transverse field. Displacements are observed which propagate along the column. A 'string' model is used to interpret the results. The significance of these studies for feedback stabilisation is discussed.

13417 Numerical investigation of reversed field pinches. Newton, A.A.; Yin-An, L.; Long, J.W.; Yeung, B.C. (UKAEA Research Group, Abingdon. Culham Lab.). pp 323-328 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The ATHENE magnetostatic two-fluid code and its partially ionized version EUROPA have been used to study reversed field pinch configurations, including a new high-beta model. This satisfies all the simplified MHD stability criteria based on magnetic pitch and leads to the useful sealing βsub(theta) proportional to theta. In the reversed field pinch regime, the high-beta model results suggest the possibility of maintaining the configuration for an appreciable fraction of its diffusion time.

13418 Effect on confinement of an unstable central region in a reverse field pinch. Robinson, D.C. (UKAEA Research Group, Abingdon. Culham Lab.). pp 273-277 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In view of the rather restrictive conditions for complete stability to MHD and resistive instabilities in the central regions of a reverse field pinch is seems unlikely that such a region can remain stable on diffusion timescales; evidence from Zeta tends to confirm this. It has been shown that such a central region can remain stable to MHD criteria provided that it possesses sufficient shear, β is not too high and the applied electric fields are of an appropriate form. Even in this case overheating on a diffusion timescale will create excessive β and give rise to unstable pressure driven instabilities.

13419 Stability of high-β tokamaks with arbitrary elongated cross sections. Tataronis, J.A.; Grossmann, W.; Weitzner, H. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). pp 563-567 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Results are presented of an MHD stability analysis of diffuse, axisymmetric toroidal plasma configurations whose cross sections are elongated in the direction of the toroidal axis. The macroscopic fluid variables are expanded in terms of two small parameters: i)kappa the inverse aspect ratio and, ii) epsilon the ratio of the minor to the major dimensions of the cross section. This expansion leads to a system of differential equations which are readily susceptible to numerical solution or, in some cases, analytical solution for the equilibrium and linearized fields to any order in kappa and epsilon. The stability analysis is based on the lowest order solutions.

13420 Stability of pinches with a reversed field in HBTX I. Verhage, A.J.L.; Robinson, D.C. (UKAEA Research Group, Abingdon. Culham Lab.). pp 267-271 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In experiments on HBTX I (major radius R = 100 cm, radius quartz wall rsub(l) = 6cm), at filling pressures of 40 mtorr Deuterium, two types of reversed field pinches, comprising pinches with self and driven reversal, are distinguished: (a) Pinches in which a major redistribution of magnetic field takes place on a timescale much shorter than that of the decay of magnetic field. (b) Pinches with configurations evolving on the same timescale as the diffusion time of the magnetic field (typically $\mu_0$sigma(r)^2/10 approximately 50 μs). Instabilities observed in these pinches are discussed and a comparison is made between the field configurations resulting from the instabilities.

13421 Optical and electrical studies of the compression and kink instabilities of reversed field pinches. Watts, M.R.C.; Verhage, A.J.L. (UKAEA Research Group, Abingdon. Culham Lab.). pp 449-454 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The behaviour of pinches on HBTX I with programmed and self reversed Bsub(z) fields, with compression ratios from 1.5 to 3 and with currents of 30 to 150 kA has been studied. Results obtained using streak photography and electrical diagnostics are given for four representative sets of conditions; 1) Stable Reversed field pinch (RFP) with peak current approximately 60 kA; 2) weakly m = 1 unstable RFP, peak current approximately 50 kA, compression ratio 2.5 which allows study of a helical kink mode with slow onset and growth rate; 3) RFP with compression ratio 1.5 current 120 kA stable to gross kink modes but observed to be unstable to localized modes, possibly pressure driven modes; 4) Stabilized Z pinch (SZP) with compression ratio 3, current 120 kA which shows a large amplitude helical kink mode associated with self generation of reversed field. The filling in each case was 40 mtorr D_2.

13422 Mass flow stabilization of plasma confined by helical magnetic fields. Wells, D.R. (Miami Univ., Fla. (USA)). pp 123-127 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The magnetohydrodynamic stability of plasma confined by helical magnetic fields is considered from two points of view. First by a straightforward normal mode analysis and second by the method of seeking minimum free energy solutions for magnetohydrodynamic equilibrium by applying the principle of least constraint. It is demonstrated that for plasmas of thermonuclear interest the energy extremum must be found subject to the constraints $\int A \rightarrow .B \rightarrow dtau$ and $\int B \rightarrow .v \rightarrow dtau$. The latter constraint corresponds to a generalized gauge symmetry that is never violated for plasmas with low viscosity. Its inclusion in the set means that there will be mass flow parallel to the magnetic field. Both the variational calculation and the normal mode analysis predict that the unstable modes of magnetic equilibria are always stabilized by plasma mass flow.

13423 Non-linear saturation of parametric instability of an Alfven wave. Elfimov, A.G.; Nekrasov, F.M. *Zh. Tekh. Fiz.;* **45**: No. 10, 2064-2068(Oct 1975). (In Russian).

Under consideration has been a nonlinear stage of a parametric instability of a HF external field of a direct magnetosonic wave decaying into two alfven ones. The consideration has been carried out in an approximation of the collisional magnetohydrodynamics. A system of equations has been obtained which describes the evolution of amplitudes of parametrically excited alfven oscillations. The system has been solved in the approximation of 'small threshold', or small β. Stationary harmonic amplitude and phase in relation to values of detuning and plasma parameters have been determined. It has been shown that, together with a resonance harmonic Hsub(m), there also takes place an excitation of the harmonic Hsub(3m) with a wave number and frequency which are three times as much as the corresponding values of the resonance harmonic. The amplitude of this harmonic has been estimated. Limits of an applicability of an one-dimensional approximation to real systems have been indicated. The results obtained in the paper for rectangular geometry are true for axial symmetric alfven oscillations of a plasma coaxial with Lsub(tr) (<<) r, where Lsub(tr) is the thickness and R-the radius of a plasma layer.

13424 Non-linear stabilization of parametric instability of potential oscillations of a magnetized plasma. Elfimov, A.G.; Nekrasov, F.M. *Zh. Tekh. Fiz.;* **45**: No. 10, 2069-2075(Oct 1975). (In Russian).

Under investigation is the nonlinear stage of parametrically excited ion-acoustic and Langmuire oscillations of a magnetized plasma with a low dissipation in a HF-uniform electric field. Two-liquid hydrodynamics equations is a drift approximation have been

used as a theoretical model. Porcesses under consideration are assumed to be isothermal. The thermal motion of ions is neglected. Oscillations are considered with phase velocities much greater than the thermal velocity of ions. The nonlinearity is assumed to be small, therefore in equations the items are taken account of to the third order inclusive. In a linear approximation the condition of resonance parametric excitation of oscillations is fulfilled only for the main mode of oscillations. When obtaining equations describing the evolution of resonance amplitudes, only non-resonance harmonics are taken into account. Solutions of equations have been found which correspond to nonlinear quasi-harmonic oscillations. General expressions are given for oscillation amplitudes and for nonlinear corrections to frequencies. Problems of the solution stability found are discussed. It has been shown that inside a plasma there is a time average potential. It is noted in conclusion that the account of correlation of phases between pairs of parametrically related waves may considerably affect the amplitude.

13425 Stability of diffuse high-beta helical systems. Freidberg, J.P.; Marder, B.M.; Weitzner, H. (Univ of Calif, Los Alamos Sci Lab, NM). *Nucl. Fusion;* **14**: No. 6, 809-820(Dec 1974).

The stability of m=1 long-wavelength kink modes in diffuse high-BETA l=0 and l=1 systems has been investigated. For l=0 it is found that new modes exist with potentially dangerous growth rates and mode structure but which degenerate into zero growth-rate modes in the sharp boundary limit. The existence of such modes provides an explanation to an apparent paradox in the literature concerning l=0 wall stabilization. For l=1, it is found that the sharp boundary wall stabilization of the gross m=1 mode remains essentially unchanged for diffuse profiles. This is favourable for the Scyllac program. 11 refs.

13426 Plasma equilibrium and stability in the scyllac toroidal sector experiments. Ellis, W.R.; Jahoda, F.C.; Kristal, R.; Quinn, W.E.; Ribe, F.L.; Sawyer, G.A.; Siemon, R.E. (Univ of Calif, Los Alamos Sci Lab, NM). *Nucl. Fusion;* **14**: No. 6, 841-863(Dec 1974).

Experiments are reported on helical plasma equilibrium and stability in the Scyllac toroidal THETA-pinch sectors which have major radii of 2.375 and 4.0 m with coil arc lengths of 5.0 and 8.4 m, respectively. In these experiments the outward toroidal drift force was compensated by a combination of l=1 helical and l=0 bumpy fields which are generated by shaping the inner surface of the compression coil or by driven l=1 windings. Time-resolved measurements were made of the gross plasma-column motion, the plasma radius, the magnetic flux excluded by the plasma, the external magnetic field, the plasma density, the electron and ion temperatures, the plasma BETA at axial locations of minimum and maximum plasma radius. These data are used to study the approach to the theoretically predicted toroidal equilibrium (including axial pressure equilibrium). The observed toroidal equilibria of the high-beta, THETA-pinch plasma are in quantitative agreement with MHD sharp-boundary theory and confirm the theoretical scaling of the equilibrium field between the 5-m and the 8-m sector experiments. 42 refs.

13427 Exact solutions of toroidal equilibrium and MHD stabilities. Oshiyama, H.; Fukutani, Y. (Kyoto Tech Univ, Jpn). *Nucl. Fusion;* **14**: No. 6, 793-796(Dec 1974).

Exact solutions are given for an axisymmetric toroidal plasma equilibrium with rectangular cross-section. The equilibrium configuration in which the current and the plasma pressure are zero at the boundary is examined by using the criterion of local stability. The equilibrium exists for large BETA, but its maximum value is limited by local instability. 9 refs.

13428 Laboratory parametric instability experiments at the plasma frequency. Chu, T.K.; Hendel, H.W.; Dawson, J.M. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 4, 111-120(1972).

Experiments in which high intensity, high frequency electric fields were used to interact with plasmas, are surveyed and significant agreements and discrepancies between experiment and theory are outlined. Experimental difficulties and future directions are indicated.

13429 Microinstabilities in mirror plasmas. Cordey, J.G. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 2, 45-50(1972).

Theoretical and experimental work on microinstabilities in mirror plasmas is summarised and some outstanding problems outlined.

13430 Particle simulation of plasmas. Dawson, J.M. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 2, 51-56(1972).

Computer simulations of plasma using particle models as a method of investigating plasma behavior is reviewed.

PLASMA WAVE PHENOMENA

13431 (EUR-CEA-FC—881) Wave propagation of the fast Alfven mode in the linearly magnetized cylindrical plasma with the effect of the plasma inhomogeneity. Kawasaki, S. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Groupe de Recherches sur la Fusion Controlee). Feb 1977. 22p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The problem of Alfven wave propagation in a linearly magnetized cylindrical waveguide is treated in the assumption of an inhomogeneous plasma. No general analytical treatment of the wave equation is shown to exist. However, in the limit of ksub(z)→0 (ksub(z) being the parallel wave number) the surface wave and the fast wave are separated to be an E-wave and an H-wave respectively; then the surface wave fields can be treated completely analytically for the parabolic density distribution. The fast wave also is treated analytically for the same distribution, but is limited to the case m=0. There appears a certain strange behavior of the radial eigenmode, which requires further investigation to be clarified. The effect of boundary conditions imposed on the wave field is then discussed together with the character of the surface wave related to the cut-off in the axial direction. The application of the results to T.F.R. experiments is always in mind throughout the discussion.

13432 Specific features of the structure of 2ωsub(0) and 3/2ωsub(0) harmonics generated laser plasma. Aleksandrov, V.V.; Vikharev, V.D.; Zotov, V.P.; Koval'skii, N.G.; Pergament, M.I. *Zh. Eksp. Teor. Fiz., Pis'ma Red.;* **24**: No. 10, 551-554(20 Nov 1976). (In Russian).

13433 (IPF—76-2) Investigation of the propagation of high-amplitude torsion ALFVEN waves. Berger, E. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). 1976. 73p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The properties of high amplitude torsion Alfven waves propagating in a cylindrical plasma with a superimposed axial homogeneous magnetic field are investigated. Starting with linear waves, an increasing wave amplitude leads to various nonlinear effects with different causes. Thus a nonlinear coupling between compression oscillations Bsub(z) and the torsion wave is observed. In the linear case this wave shows only an azimutal magnetic component Bsub(phi). With the results of the linear calculation and a perturbation calculation based on the linear theory, the creation of these compression oscillations can be explained qualitatively and also quantitatively in part. For example, the calculated radial amplitude of the first harmonic is in accord with the experimental results. Amplitude-dependent radial profile changes and phase distributions are observed and can be interpreted satisfactorily. The propagation of torsion Alfven waves with sufficiently high amplitudes produce changes in the plasma parameters in such a way that microinstabilities, in the present case ion sound instabilities, are excited by the wave, leading to a higher collision frequency between electrons and ions. This results in a lower electrical conductivity (turbulent conductivity) of the plasma which can be observed by a higher spatial damping of the wave. A strong heating mechanism (turbulent heating) is connected with this anomalous wave damping.

13434 (IPP—6/154) Anomalous electron transport equations for ion sound and related turbulent spectra. Dum, C.T. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Mar 1977. 61p. Dep. NTIS (US Sales Only), PC A04/MF A01.

A complete set of anomalous electron transport equations is derived for ion sound and related spectra. Turbulence causes a drastic modification of magnitude and structure of the transport effects. The self-consistent distribution function is also used to determine wave growth. The important role of the new contributions to wave growth, restistivity and heat conduction in experiments as well as their description by codes are discussed.

13435 (NRL-MR—3569) Steady-ablation model of accelerating laser-target slabs. Felber, F.S. (Naval Research Lab., Washington, D.C. (USA)). Sep 1977. Contract ES-77-A-01-6021. 14p. Dep. NTIS, PC A02/MF A01.

A steady-state model of a plasma slab, accelerated by interaction with laser radiation, determines temperature, velocity, and density profiles and boundaries consistent with laser intensity and wavelength, and slab mass and acceleration. Density profile modification is caused by laser pressure. Plasma flows subsonically into the critical surface, supersonically out.

13436 Non-linear coupling of a magneto-acoustic wave with a group of high frequency electron cyclotron waves. Das, K.P. (Kalyani Univ., West Bengal (India). Dept of Mathematics). *Plasma Phys.;* **19**: No. 8, 707-714(Aug 1977).

Using the adiabatic approximation a dispersion relation is obtained for the propagation of a magneto-acoustic wave in the presence of a group of high-frequency electron-cyclotron waves. This dispersion relation is simplified for the case of a narrow spectrum of electron-cyclotron waves. It is found that in the presence of a low energy high-frequency wave, the magneto-acoustic wave grows exponentially with time if the phase velocity of this wave is very near the component of group velocity of the electron-

cyclotron wave along the direction of propagation of the magneto-acoustic wave.

13437 Non-linear scattering of the electron-sound oscillations of a plasma on ions. Amein, W.H.; El-Nagge, I.A.; Sizonenko, V.L. (Atomic Energy Commission, Cairo (Egypt)). *Plasma Phys.;* **19**: No. 7, 651-661(Jul 1977).

The effect of plasma ions upon the process of non-linear scattering of the electron-sound oscillations excited by the current flowing perpendicular to the magnetic field is investigated. It has been shown that in the case of excitation of three-dimensional wave packets, non-linear scattering of the waves on ions is small so that the oscillation scattering on plasma electrons plays the main role in the instability saturation. The case of two dimensional wave packets requires a new approach, a new model of weak turbulence theory making allowance for the broadening of resonant denominators at the expense of the wave growth increments.

13438 Stability of cyclotron radiation emitted perpendicularly to a magnetic field. Audenaerde, K. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). *Plasma Phys.;* **19**: No. 7, 663-667(Jul 1977).

For wave propagation perpendicular to the static magnetic field, it is investigated whether or not the resonant absorbtivity at the cyclotron frequency harmonics can change spin, i.e. turn unstable. The conclusion is that this is possible, but only likely to occur in the extraordinary mode in a plasma where runaway electrons have a sufficiently high perpendicular energy.

13439 Electrostatic plasma turbulence. Pt. 2. The nonlinear dispersion relation and fluctuation spectrum. Barr, H.C.; Boyd, T.J.M. (University Coll. of North Wales, Bangor (UK)). *J. Plasma Phys.;* **17**: No. , p. 503-517(Jun 1977).

The effects of the diffusion and drift across a magnetic field induced by a turbulent spectrum of fluctuations on the propagation of an unstable spectrum of modes are examined. A nonlinear dispersion relation is derived in a general closed form. This is then examined in the limit of short wavelengths (i.e. wavelengths much less than the gyroradii). It is found that modes supported by the magnetic field are quashed whenever a particle may diffuse a wavelength per gyroperiod. In the context of current-driven instabilities (current across the magnetic field), electron instabilities are quashed but not the ion-acoustic. The dispersion characteristics of the latter are unchanged except in that the drift which sustains the instability is altered by the presence of a turbulent (E x B) type drift. Depending on the level of fluctuations and magnetic field strength, this may amount simply to a rotation of the cone of unstable modes or may form a counter-current which in turn suppresses the original current driving the instability. The problem of calculating the fluctuation spectrum of the electric field is also considered since this is essential for a self-consistent computation of the diffusion tensor turbulent drift appearing in the non-linear dispersion relation.

13440 Four-wave interactions in plasmas. Boyd, T.J.M. (University Coll. of North Wales, Bangor (UK)); Turner, J.G. (Polytechnic of Central London (UK)). *Lett. Nuovo Cim.;* **1**: No. 6, 477-484(Jun 1977).

The interaction of four waves in a warm magnetized plasma is studied using a Lagrangian formalism. General expressions for coupling coefficients are presented and the coupled-mode equations describing the interaction are derived.

13441 Effect of a high-frequency potential of the reflexion of p-polarized electromagnetic waves from the plasma layer. Dolgopolov, V.V.; El-Shereif, R.N.; Hussein, A.M. (Atomic Energy Commission, Cairo (Egypt)). *J. Plasma Phys.;* **17**: No. , p. 537-541(Jun 1977).

It is shown that, in the case of incidence of p-polarized waves onto a plane-parallel plasma layer, the wave field pressure can cause the electromagnetic field to penetrate into the plasma, which is opaque in the linear approximation for the given waves. The plasma density average over the region of the electromagnetic field does not change.

13442 Jumps in the nonlinear reflectivity of an overdense plasma layer. Andreev, N.E. (AN SSSR, Moscow. Fizicheskij Inst.); Sauer, K. (Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Elektronenphysik). *Phys. Lett., A;* **61**: No. 3, 165-166(2 May 1977).

The temporal evolution of the nonlinear reflection coefficient of an overdense plasma layer is calculated numerically. Above a critical amplitude of the incident wave it temporarily drops to small values.

13443 Ion acoustic waves excited by boundary sheaths. Christensen, T.; Heronkowitz, N. (Iowa Univ., Iowa City (USA). Dept. of Physics and Astronomy). *Phys. Lett., A;* **61**: No. 3, 170-172(2 May 1977).

Low frequency signals applied to a grid immersed in a plasma excite ion acoustic waves at the plasma boundaries simultaneous with those excited at the grid. A mechanism is suggested which involves the 'direct coupled signal'.

13444 Wave and particle measurements near the lower-hybrid frequency. Colestock, P.L.; Getty, W.D. (Michigan Univ., Ann Arbor (USA). Electron Physics Lab.). *Plasma Phys.;* **19**: No. 5, 455-465(May 1977).

Experimental results are presented on lower-hybrid waves excited in a plasma column by an electrostatic coupler. It is found that the observed wave patterns, which clearly show resonance cones, are as predicted by a theory based on the superposition of bounded-plasma eigenmodes for a source with a wide ksub(z), spectrum, and are also consistent with the WKB resonance-cone formulation. Results on electron heating and plasma loss produced by lower-hybrid waves are also presented.

13445 Observation of refraction and convergence of ion acoustic waves in a plasma with a temperature gradient. Nishida, Y.; Hirose, A. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Physics). *Plasma Phys.;* **19**: No. 5, 447-453(May 1977).

The refraction and convergence of ion acoustic waves are experimentally investigated in a magnetized plasma with an electron temperature gradient. When ion acoustic waves are launched parallel to the field lines the waves converge toward the interior of the plasma column where the electron temperature is lower, in good agreement with theoretical prediction. Wave interference is also observed.

13446 Stationary nonlinear interaction between high- and low-frequency waves and the generation of density cavities in a plasma. Baumgaertel, K.; Sauer, K. (Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Elektronenphysik). *J. Plasma Phys.;* **17**: No. , p. 185-199(Apr 1977).

The nonlinear interaction of a high-frequency wave (transverse or longitudinal) and an ion-acoustic wave in a homogeneous plasma is investigated. The waves are assumed to be simultaneously excited by two localized external sinusoidal disturbances with frequencies ω_0 and ωsub(s) in the plasma. From the coupled wave equations a system of ordinary differential equations for the spatial change of the amplitudes of the interacting waves (including the primary frequencies ω_0, ωsub(s) and the mixed frequencies ω_0 +- ωsub(s)) and a zero-frequency density disturbance is derived. The spatial development of the high-frequency amplitudes is characterized by localized regions of high intensities, coupled with local depressions of the plasma density. The influence of the initial amplitudes and the frequencies ω_0, ωsub(s) on the maximum of the primary high-frequency amplitude and the 'cavity' depth is shown. The numerical results are compared with conclusions from a simplified model of three resonantly interacting normal modes.

13447 Nonlinear, superluminous, periodic waves in a plasma with magnetic field. Clemmow, P.C. (Cambridge Univ. (UK). Dept. of Applied Mathematics and Theoretical Physics). *J. Plasma Phys.;* **17**: No. , p. 301-316(Apr 1977).

The exact theory of plane waves of fixed profile travelling with constant velocity cz/n ($0 <= n <= 1$) through a uniform, cold, electron-ion plasma in a magnetostatic field is examined in terms of the governing equations referred to the frame of reference in which there is no space dependence. Canonical periodic solutions are defined as those with zero average rate of flow of electrons (and a fortiori of ions) in the laboratory frame. It is shown that the equations lead to a second-order, nonlinear, ordinary vector differential equation for the reduced velocity u of the electrons. A scalar first integral is obtained, from which it is deduced that the path in u-space of any solution lies within a bounded domain. It is shown that, for propagation across the magnetic field, a polarization is possible in which the particle velocities and the electric field are orthogonal to the magnetic field. The simpler model of an electron plasma is considered. Explicit canonical periodic solutions, with the stated polarization, are obtained for propagation across the magnetic field in the case $n = 0$ and the case n approximately equal to 1. These support the conjecture that, for any fixed value of n in [0,1], there are two 'modes' of arbitrary amplitude which reduce to the familiar monochromatic waves of linear magneto-ionic theory in the small amplitude limit.

13448 Ionic thermal effects on ion-acoustic waves in plasmas with negative ions. Das, G.C. (Pennsylvania Univ., Philadelphia (USA)). *Plasma Phys.;* **19**: No. 4, 363-368(Apr 1977).

Ion-acoustic waves in warm-ion plasma which includes some negative ions are studied using the properties of a modified Korteweg-de Vries equation. The equation, which describes the amplitude, width and velocity variation of the solitons is studied, taking into account the ion thermal effects. As in the case of a cold plasma, the warm negative ions also introduce a critical concentration at which the wave breaks up, which could play an important role in exploiting the ion-heating mechanism. The results obtained are compared with those for plasmas with cold ions.

13449 Theory of Langmuir solitons. Gibbons, J.; Thornhill, S.G.; Wardrop, M.J.; Ter Haar, D. (Oxford Univ. (UK). Dept. of Theoretical Physics). *J. Plasma Phys.;* **17**: No. , 153-170(Apr 1977).

A Lagrangian density is found from which the equations of motion for the Langmuir solitons follow in the usual way. It is shown how this Lagrangian leads to the usual conservation laws. For the one-dimensional case a consideration of these conservation laws can help in understanding some of the results obtained in numerical experiments on the behaviour of a strongly turbulent plasma. It is shown that the situation in the three-dimensional case may be fundamentally different, and the near-sonic perturbations and Karpman's treatment of these is discussed.

13450 Propagation of the higher-order Landau modes of electron plasma waves. Ikezawa, S.; Kawai, Y.; Hara, T.; Nakamura, Y.; Itoh, T.; Kawabe, T. (Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science). *J. Plasma Phys.;* **17**: No. , 250-257(Apr 1977).

Propagation of electrostatic electron waves whose frequency is smaller than the electron plasma frequency in a large unmagnetized plasma is investigated both experimentally and theoretically. When a receiver is close to a transmitter, free-streaming electrons are detected owing to their large capacity for excitation. When the distance between the receiver and the transmitter becomes large, the third-order Landau mode is observed due to its smaller damping than that of free-streaming electrons. Finally, a dip in amplitude of the wave, caused by interference by the higher-order Landau modes, is seen. The results are in reasonable agreement with numerical calculation assuming a dipole excitation for the wave.

13451 Stability of solitons to transverse perturbations. Infeld, E. (Institute of Nuclear Research, Warsaw (Poland)); Rowlands, G. *Plasma Phys.;* **19**: No. 4, 343-348(Apr 1977).

Envelope solitons are shown to be stable with respect to three-dimensional, long wavelength perturbations. Apparent contradictions with previous work of other authors are explained.

13452 Alfven waves in a stochastic magnetic field. Mittal, M.L.; Prahalad, Y.S. (Indian Inst. of Tech., Bombay. Dept. of Mathematics). *J. Plasma Phys.;* **17**: 147-151(Apr 1977).

Parametric amplification of Alfven waves in a plasma, subjected to a spatially uniform but temporally stochastic magnetic field, is investigated. The analysis is made using Bogoliubov and Mitropolsky's asymptotic method and Stratanovich's method for stochastic differential equations. This enables us to obtain the probability distribution function for the evolution of the wave, under Markovian approximation. Thus, a complete statistical characterization of the wave can be obtained, if needed. It is shown that Alfven waves with wavelengths larger than the radius of the plasma column are amplified with probability unity, if the power spectral density of the fluctuating field at twice the wave frequency is non-zero.

13453 Electromagnetic radiation from line sources embedded in a moving bounded magnetoplasma sheath. Mukherjee, P.K. (Delhi Univ. (India). Dept. of Physics and Astrophysics). *J. Plasma Phys.;* **17**: No. , 171-184(Apr 1977).

The problem of electromagnetic radiation from electric and magnetic line sources embedded in a moving bounded magnetoplasma sheath situated over a perfectly conducting plane is studied. The radiation fields due to the line sources consist of both E and H modes, excited simultaneously in the moving sheath. However, when the magnetic field lies parallel to the line source and is oriented normal to the direction of the sheath motion, the modes become decoupled. The far-zone radiation fields for both the electric and the magnetic line sources have been obtained, using the method of saddle-point approximation. The corresponding radiation patterns are also obtained and their variation studied as a function of the magnetic field, the location of the line source, the thickness and the velocity of the moving plasma sheath. It is found that the fields radiated by an electric line source remain unaffected by the presence of an ambient magnetic field and that, in the presence of a sufficiently intense magnetizing field, the magnetic line source over a perfectly conducting plane radiates as though surrounded by vacuum.

13454 Ion dynamics in a perpendicular collisionless shock. Sherwell, D.; Cairns, R.A. (Saint Andrews Univ. (UK)). *J. Plasma Phys.;* **17**: p. 265-279(Apr 1977).

Some properties of perpendicular collisionless shocks are investigated, using a model in which the ion orbits in the shock are assumed to be determined by the average electric and magnetic fields in the shock. These fields are modelled, with the jump in magnetic field across the shock being determined by the conservation relations, and the potential jump determined self-consistently within the model, using the fact that the mean ion velocity downstream of the shock is determined by the conservation relations. Extensive numerical calculations of ion orbits show that effective ion heating can occur in the absence of any dissipative process, with the energy residing in non-Maxwellian velocity distributions in the downstream regions. Results on this and on a number of other features of shock waves, agree well with experiments.

13455 Locally excited magnetohydrodynamic waves in a uniform cylindrical plasma waveguide. Sy, W.N.C. (Flinders Univ. of South Australia, Bedford Park. School of Physical Sciences). *J. Plasma Phys.;* **17**: No. , 281-300(Apr 1977).

The guided modes of Woods' magnetohydrodynamic waveguide for a uniform, cylindrical plasma are shown to satisfy a homogeneous wave equation whose differential operator is the product of eight Helmholtz operators. The propagation constants of the Helmholtz operators are the characteristic roots of an 8 x 8 matrix which is derived and written down explicitly. This reformulated theory is extended to include localized sources which excite the guided modes. For certain cases, the Green's functions for the differential operators can be represented by Dini expansions in terms of modal eigenfunctions, which manifestly satisfy the boundary conditions. For the case of MHD waves excited by an azimuthally symmetric current source in a resistive, pressureless, inviscid, fully ionized plasma, a detailed solution is obtained which is in good qualitative agreement with experiments.

13456 Shocklike solutions of the Korteweg-de Vries equation. Tran, M.Q.; Appert, K.; Hollenstein, C.; Means, R.W.; Vaclavik, J. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Plasma Phys.;* **19**: No. 4, 381-385(Apr 1977).

Plasma response to a piston driver has been modelled by the Korteweg-de Vries equation. The numerical shocklike solutions are evolving solitons similar to the asymptotic solutions of Gurevich and Pataevski (1974). Quantitative experimental agreement is found with low-amplitude shocklike structures.

13457 Properties of nonlinear waves excited on electron bunch injection into plasma. Gladkij, A.M.; Kovalenko, V.P.; Yushmanov, P.N. (AN Ukrainskoj SSR, Kiev. Inst. Fiziki). *Zh. Eksp. Teor. Fiz., Pis'ma Red.;* **24**: No. 10, 533-537(20 Nov 1976). (In Russian).

13458 Waves in an inhomogeneous plasma with Hall dispersion. Ruderman, M.S. *Fluid Dyn. (USSR) (Engl. Transl.);* **11**: No. 5, 762-766(Sep-Oct 1976).

The evolution of steady-state periodic solutions of the Korteweg-de Vries equation (the so-called cnoidal waves), propagating along the direction of the gravitational force with an arbitrary orientation of the magnetic field, is studied for plasma characterized by Hall dispersion and Joule dissipation using the magnetohydrodynamic approximation. The wavelength is regarded as much shorter than the characteristic scale of the inhomogeneity. The dependence of the wave amplitude on the distance to the source of the wave is considered for various limiting cases. The behavior of the wave depends on the temperature distribution in the medium. In the particular case of an isothermal atmosphere, the problem is solved analytically for a cold plasma in the absence of dissipation. The amplitude of both fast and slow waves increases when the wave travels upward and diminishes when the wave travels downward. The nonlinearity of the wave (i.e., the parameter characterizing the deviation of the wave from sinusoidal form) diminishes in the case of fast magnetoacoustic waves when the wave travels upward and increases when the wave travels downward. The situation is reversed for slow magnetoacoustic waves. 9 refs.

13459 Nonlinear interaction of the surface waves at a plasma boundary. Dolgopolov, V.V.; El-Naggar, I.A.; Hussein, A.M.; Khalil, Sh.M. (Atomic Energy Authority, Cairo, Egypt). *Physica, B, C;* **83**: No. 2, 241-243(Jun 1976).

Amplitudes of electromagnetic waves with combination frequencies, radiating from the plasma boundary due to nonlinear interaction of the surface waves, have been found. Previous papers on this subject did not take into account that the tangential components of the electric field of waves with combination frequencies were discontinuous at the plasma boundary.

13460 Effect of a high frequency potential on the reflection of s-polarized electromagnetic waves from a plasma layer. Dolgopolov, V.V.; El-Shereif, R.N.; Hussein, A.M. (Atomic Energy Authority, Cairo, Egypt). *Physica, B, C;* **83**: No. 2, 244-246(Jun 1976).

It has been shown that, in the case of incidence of s-polarized waves onto a plane-parallel layer, the wave field pressure can cause the penetration of the electromagnetic field into the plasma whereas, in the linear approximation, the electromagnetic field cannot penetrate into the plasma due to the skin-effect. In this, the average plasma density over the region occupied by the electromagnetic field, does not change.

13461 Spectrum of turbulence of an intense Langmuir condensate. Khakimov, F.Kh.; Tsytovich, V.N. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)). *Zh. Tekh. Fiz.;* **45**: No. 10, 2057-2063(Oct 1975). (In Russian).

The object of the paper ia a search of a stationary spectrum of Langmuire oscillations outside a condensate in the presence of a strong turbulence inside a condensate. One-dimensional Langmuire turbulence with a nonlinear wave dispersion due to the presence of a

condensate, has been considered. The effect of a condensate on processes of spectral pumping over of waves outside a condensate, has been analyzed. The total spectrum of turbulent pulsations in the range of the existance of linear and nonlinear dispersion has been found. In conclusion it is noted that the intense Langmuire condensate essentially changes the spectrum near the condensate. Away from the range of the condensate the spectrum remains K^{-2}, where K is the wave number.

13462 Collisionless absorption of waves in plasma. Tyzhnenko, A.G.; Khizhnyak, N.A. (Khar'kovskij Gosudarstvennyj Univ. (Ukrainian SSR)). *Zh. Tekh. Fiz.;* **45**: No. 10, 2076-2082(Oct 1975). (In Russian).

Propagation of high frequency transverse waves in a plasma with developed fluctuations of plasma inhomogeneities changing in time is under investigation. The space between inhomogeneities is filled in a homogeneous plasma. Inhomogeneities are considered to be distributed chaotically, that is formally equivalent to a position of inhomogeneities in points of a cubic spatial lattice. The object of the work is reduced to determining fields scattered by one body and to determining the dielectric constant of a cubic lattice consisting of many such bodies. Scattering has been considered of a plane electromagnetic wave with frequency ω on a plasma formation whose concentration is changing by a harmonic law with the frequency $\Omega << \omega$. The dielectric constant tensor in a resonance case is considerably different from the one for a nonresonance case; the difference is the presence of constant terms in real Rsub(k)(t) and imaginary Isub(k)(t) parts. The presence of the imaginary part of the dielectic constant tensor of the medium means that the transverse wave energy is pumped over into the energy of plasma own oscillations. It has been shown that if the time average of the imaginary part of the dielectric constant tensor epsilonsub(kk)(ω, t) does not equal to zero, the pumping over energy is irreversible. It follows from the expressions obtained that for suffuciently intense oscillations of electric fields in a plasma the energy dissipation of a transverse wave takes place mostly due to electron-wave 'collisions'.

13463 'Collisionless' absorption of electromagnetic waves in a small plasma volume with a free boundary. Barinov, V.I.; Karfidov, D.M. (AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* **1**: No. 4, 638-646(Jul 1975). (In Russian).

Investigations are carried out on the interaction of 10-cm pulsed radiation with a flow of a collisionless plasma at initial conditions favourable for the linear transformation of waves. In a wide range of SHF power corresponding to νsub(E)/νsub(Te) approximately 10sup(-5)/1 the absorption coefficient D^2 is shown to be approximately the same (at the beginning of a SHF pulse at least). The absorption sets in practically instantaneously and is followed by a rapid decay of a plasma and by production of accelerated electrons. At νsub(E)/νsub(Te) > or approximately 1 the values of D^2 decrease already at the front of a SHF pulse apparently due to intensive plasma decay.

13464 'Slow' nonlinear phenomena and 'anomalous' absorption of electromagnetic radiation in plasma. Barinov, V.I.; Gekker, I.R.; Ivanov, V.A.; Karfidov, D.M. (AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* **1**: No. 4, 647-654(Jul 1975). (In Russian).

Investigations are carried out on the interaction of 10-cm pulsed radiation with a flow of a collisionless plasma (the maximum concentration is larger than the critical one nsub(c)) at initial conditions unfavourable for the intensive linear transformation of waves. The anomalously strong absorption arises with a time delay (1/3 s) and only when the wave pressure exceeds the electron pressure of plasma (Esub(0)sup(2)/8π > or approximately nsub(c)Tsub(e)). Before a considerable absorption takes place a deformation of the leading front of plasma with substantial increase of the concentration in the central part of the flow. This fact leads to favourable conditions for the wave linear transformation.

13465 Self-focusing of a negative ion beam while exciting ion plasma oscillations. Simonenko, L.S.; Soloshenko, I.A. (AN Ukrainskoj SSR, Kiev. Inst. Fiziki). *Fiz. Plazmy;* **1**: No. 4, 635-637(Jul 1975). (In Russian).

The fact of a radial focusing of a fast negative ion beam (νsub(o) > > Csub(s), where νsub(o) is the beam velocity, Csub(s) is the ion sound velocity) has been experimentally established while the excitation of Langmuir ion oscillations of plasma. The focusing is shown to take place only in a specific regime in plasma produced by ionization of a gas by a negative ion beam. In the regime dsub(e) > > rsub(o) > >dsub(i) (dsub(e), dsub(i) are the Debye radii of plasma electrons and ions, rsub(o) is the beam radius). Consequently, the beam can excite oscillations with the zero radial mode.

13466 Simple approximate method for assessment of density in reflected concentric shock-waves. Kaliski, S. (Pol Acad of Sci, Warsaw). *Bull. Acad. Pol. Sci., Ser. Sci. Tech.;* **23**: No. 3, 191-195(1975).

Simple approximate formulae are submitted for appraisal of the density for concentric shock-waves, spherical and cylindrical, incident and reflected from the center in perfect gas. The appraisals obtained enable one to compute rapidly, for any gamma, the compression with an error which does exceed a score percent, which is essential for the practice, for rapid interpretation of experiments, in particular. 7 refs.

13467 Nonwave-like dynamical processes in plasma. Dupree, T.H. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 2, 33-38(1972).

An indication is given how clumps and fluid-like turbulent processes can occur in plasmas and further research suggested on specific problems.

FUSION POWER PLANT TECHNOLOGY

13468 (ANL/FPP—77-1) **Fusion power program quarterly progress report, January—March 1977.** Stacey, W.M. Jr.; Darby, J.B. Jr.; Harkness, S.D. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 108p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for each of the 6 included sections. (MOW)

13469 (GA-A—14538) **Review of the current status of linear hybrid reactor concepts.** Schultz, K.R. (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-03-0167-038. 38p. (CONF-770350—3). Dep. NTIS, PC A03/MF A01.

From US/USSR workshop on hybrid reactor design; Moscow, USSR (14 Mar 1977).

A review was made of the current status of linear fusion-fission hybrid reactor design studies in the USA. The linear hybrid reactor concepts reviewed include the linear theta-pinch hybrid reactor being studied at Los Alamos Scientific Laboratory, the electron beam-heated solenoid hybrid reactor under development at Physics International Co., the laser-heated solenoid hybrid reactor being investigated at Mathematical Sciences Northwest, Inc., and the linear fusion waste burning reactor being studied at General Atomic Company. The discussion addresses confinement and heating mechanisms for each concept, as well as the hybrid blanket designs. The current state of the four reactor designs is summarized and the performance of the various concepts compared.

13470 (INIS-mf—3663, pp 45-47) **Separation-free breeding nuclear power system.** Greenspan, E.; Schneider, A. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev; Ben-Gurion Univ. of the Negev, Beersheba (Israel)). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13471 (PPPL—1371) **SMARTOR: a small-aspect-ratio torus for demonstrating thermonuclear ignition.** Jassby, D.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Sep 1977. Contract EY-76-C-02-3073. 37p. Dep. NTIS, PC A03/MF A01.

A tokamak with 2.6-m major radius and aspect ratio of 1.9 is proposed for demonstrating thermonuclear ignition in deuterium-tritium. The 6-MA plasma current is established in part by coinjection only of 40 MW of 80-keV neutral beams (inducing approximately 2 MA at low density) and in part by the flux swing of the equilibrium-field system (inducing approximately 4 M as the plasma pressure is increased)—there is no central current transformer and no poloidal-field coils inboard of the plasma. The core of the device consists simply of a 1.9-m-diameter steel-reinforced conducting trunk formed by coalescence of the inner legs of the toroidal-field coils. Alternate designs are presented, each with an aspect ratio of 1.9, with R/sub 0/ = 2.6 m and a plasma density sufficiently large to provide a comfortable safety margin for achieving ignition conditions. The first design features higher beta (anti β = 0.10, b/a ~ 1.6) with low tensile stress at the copper trunk (1000 kg/cm^2), while the second features lower beta (anti β = 0.06, b/a approximately 1.2) with high tensile stress (1800 kg/cm^2). Extension of this small-major-radius, small-aspect-ratio configuration to an economically practical fusion reactor is also examined.

13472 (UCID—17622) **Perspective on the fusion-fission hybrid reactor.** Bender, D.J.; Lee, J.D.; Moir, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1977. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

The hybrid reactor's role as a source of fuel for fission converter reactors is investigated. The role of the hybrid reactor in the energy economy, the interface between the hybrid reactor and the present fusion program, implications of the Carter Energy Plan, and the rationale for further hybrid reactor studies are discussed.

13473 Characteristics of the NASA Lewis Bumpy Torus plasma generated with high positive or negative applied potentials. Roth, J.R.;

Gerdin, G.A. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). *Plasma Phys.;* **19**: No. 5, 423-446(May 1977).

The toroidal ring of plasma contained in the NASA Lewis Bumpy Torus may be biased to positive or negative potentials approaching 50 kV by applying d.c. voltages of the respective polarity to 12 or fewer midplane electrode rings. The electric fields, which are responsible for raising the ions to high energies by E x B/B^2 drift, then point radially outward or inward. The influence of electric field direction on ion kinetic temperatures and ion heating efficiency was investigated. Under equivalent conditions of magnetic field, deuterium background pressure, and midplane electrode voltage, the ion kinetic temperatures and ion heating efficiencies were virtually the same whether all 12 midplane electrodes were positive or negative. Deuterium ion kinetic temperatures of 340-2500 eV were observed. The ion heating efficiency ranged from 5 to 22%, increases with increasing background pressure or magnetic field, decreases with increasing anode voltage, and is higher in the high pressure than in the low pressure mode of operation.

13474 Nearer to the fusion switch-on. Maple, J.H.C. *Spiegel;* **15**: No. 1, 60-62(Mar 1977).

Nuclear fusion promises us a new, inherently safe source of energy using cheap, readily available fuels. Believed to be the source of the sun's energy, it has been demonstrated on earth in a violent and uncontrolled way in the hydrogen bomb; but to benefit mankind, fusion must be controlled and contained in conveniently-sized reactors.

13475 Generation of power by thermonuclear reaction. Kundu, D.N. (Saha Inst. of Nuclear Physics, Calcutta (India)). *Sci. Cult.;* **43**: No. 1, 7-17(Jan 1977).

When two light nuclei undergo thermonuclear fusion, they yield a balance mass as energy. This fusion energy has been proposed as an energy source in preference to fission energy which suffers from the problem of radioactive waste disposal. Deuteron, triton and ^{3}He are the light masses most suitable for application of fusion process as a source of energy. For fusion, these nuclei must be brought to the physical state of plasma i.e. the temperature and density of the order of 10^8 sup(o)K and 10^{14} cm^{-3} respectively. The plasma must be contained for a sufficient length of time within a vessel without physical contact with its material involved. Four concepts for heating and containment of plasma for fusion devices, namely, mirror, theta pinch, Tokamak and laser pellet are explained. Research work on the Tokamak and the laser pellet in USA and USSR is surveyed in brief.

13476 Recent developments in high-beta plasma research on theta and Z pinches. Ribe, F.L. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 1, 17-22(1977).

A brief summary is given of recent world-wide research on pinch devices. Current developments toward toroidal pinch research are described.

13477 Current status and the future of controlled nuclear fusion. Rutscher, A. (Ernst-Moritz-Arndt-Universitaet, Greifswald (German Democratic Republic). Sektion Physik/Elektronik). *Energietechnik;* **26**: No. 12, 531-535(Dec 1976). (In German).

The current status and the future of the controlled nuclear fusion are outlined. Plasma heating methods and plasma confinement are discussed as main problems in developing nuclear fusion reactors. Present and future thermonuclear devices are briefly reviewed considering plasma temperature and the Lawson criterion. An operation scheme of a future fusion power plant is given.

13478 Results of SPICA. Bobeldijk, C.; Von Heijningen, R.J.J; Hoekzema, J.A. (Association Euratom-FOM, FOM-Institut voor Plasmafysica, Rijnhuizen, Jutphaas, (Netherlands)) (and others). pp 493-496 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In the screw-pinch experiment SPICA (R/r = 60/20) the capacitor bank for the bias field has been enlarged to improve the control of β. At a filling pressure of 10 mTorr D_2 a β of 20% could be obtained as measured by Thomson scattering (qsub(w) = 1.5, Isub(zp) = 285 kA, Bsub(z) = 1.2 T, Tsub(e) approximately Tsub(i) = 50 eV at 10μs, nsub(e) = 7x $10^{21}/m^3$). The vertical field inside the Isub(z) feed flange has been minimized, in the presence of plasma, to 5 x 10^{-3} T by a suitable current distribution in the flange. Magnetic probe measurements have shown that the currents in the pressureless plasma outside the main column fall off sharply in the outer layers. Emission of X-rays occurs several μs after the start of the main discharge and is strongly dependent on initial conditions.

13479 Reversed field pinches. Bodin, H.A.B. (UKAEA Research Group, Abingdon. Culham Lab.). pp 39-57 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The main properties of the reversed field pinch are summarised. Many of the theoretical predictions, including stability at β approximately 30% on ideal and dissipative MHD, have been confirmed in low temperature collisional plasma on HBTX 1, using field control; approximately classical values of the lifetime of the configuration tausub(c) and energy confinement time tausub(e) were also measured. The principal limitations of this experiment were the low values of $\omega\tau$ and the fact that β and the pressure gradient quickly rose to values well in excess of the ideal MHD stability limit, so that although peak temperatures increasing as I^2 were observed they were not sustained. In ZETA where the configuration was set up by self-reversal values of tausub(E) and ntau comparable to those found in Tokamaks of today were observed at relatively high ωsub(ce)tausub(ei) with Tsub(e) approximately 150.200 eV and β approximately 10%. However, the lifetime of the configuration, although approximately classical with respect to the observed electron temperature in the outer region, was limited because this temperature was low. Both tausub(E) and β were considerably less than classical predictions probably because of the turbulent core. There was little field control (none of Bsub(phi)) and the configuration itself was not optimum in the field reversal ratio and shear, and could not have confined plasma with $\beta > 10\%$, so it is not surprising that there were strong fluctuations in the interior region due to overheating. Future theoretical work is proposed.

13480 Bibliography on reversed field pinches: 1958-1975. Dancy, D.J. (UKAEA Research Group, Abingdon. Culham Lab.). pp 605-622 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

This bibliography lists all relevant papers discovered by a search of the conference literature since 1958, and in addition many of the papers to which they referred. The list was originally compiled in August 1975 in time for the Pulsed High Beta Conference at Culham, but has since been updated to include all relevant papers presented both at that conference and at the 7th European Conference on Controlled Fusion and Plasma Physics, Lausanne, and the references which those papers listed. An author index has also been added.

13481 Scyllac fusion test reactor design. Linford, R.K.; Oliphant, T.A.; Thomassen, K.I. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 569-574 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The SFTR is a proposed 80-m diameter D-T burning toroidal theta pinch. The system is designed to achieve Q = 1 where Q is the ratio of the total thermonuclear energy output to the maximum stored energy in the plasma. SFTR design studies will provide valuable guidance to the Scyllac related research and to the needed technological development. The portion of the system directly related to the plasma confinement, stability, and heating, is described, and the approach used to obtain an operating point consistent with Q = 1, m = 1 stability, and technological limitations is outlined.

13482 NRL LINUS program. Robson, A.E.; Turchi, P.J. (Naval Research Lab., Washington, D.C. (USA)). pp 477-481 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Work to date has consisted mainly of computer modelling, deriving scaling laws and preliminary liner compression experiments. In this paper we discuss ways in which the concept might be developed into a viable approach to controlled fusion.

13483 Some design parameters of a screw-pinch reactor. Schuurman, W.; Hoekzema, J.A.; van der Laan, P.C.T.; Bobeldijk, C. (Association Euraton-FOM, FOM-Institut voor Plasmafysica, Rijnhuizen, Jutphaas, (Netherlands)). pp 581-585 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

At appropriate q-values a screw-pinch plasma is theoretically in stable equilibrium at values of β up to 25%. For a screw-pinch reactor, the main geometrical and physical parameters are derived from existing design equations and from formulas for implosion heating and adiabatic compression in the presence of a bias field. This fast heating method is chosen to ensure pitch conservation of inward moving field lines. Numerical examples show the strong influence of the maximum permissible Esub(THETA) at the wall.

13484 Electromagnetic implosion of large diameter liners. Turchi, P.J.; Robson, A.E. (Naval Research Lab., Washington, D.C.

(USA)). pp 483-487 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Successful electromagnetic implosions of large radius solid metal liners have been demonstrated, with radial compression ratios of 28 and peak magnetic fields in excess of 1.3 Mgauss. Such systems exhibit small scale elastic-plastic buckling, and strain hardening so their diagnosis, and application in fusion power systems does not appear useful. Rotationally stabilized liquid metal liners, however, could provide the basis for repetitive, reversible creation of high energy density plasmas. It will probably be necessary, however, to control the liner motion more strictly than in the present experiments, in particular, by means of free pistons at the outside surface to eliminate hydrodynamic instabilities. If this can be accomplished then a new generation of electromechanical devices will be possible, allowing relatively simple and compact, pulsed high beta fusion reactors.

13485 Reactor burning calculations for a model reversed field pattern. Yeung, B.C.; Long, J.W. (Oxford Polytechnic, Headington (UK)); Newton, A.A. (UKAEA Research Group, Abingdon. Culham Lab.). pp 575-579 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

An outline pinch reactor scheme and a study of electrical engineering problems for cyclic operation has been further developed and a comparison of physics aspects and capital cost made with Tokamak which has many similar features. Since the properties of reversed field pinches (RFP) are now better understood more detailed studies have been made and first results of burn calculations given. Results of the burn calculations are summarised. These are based on a D-T burning model used for Tokamak with changes appropriate for RFP.

13486 Role of hybrid reactors in the world energy system. Golovin, I.N. *At. Energ. (USSR);* **39**: No. 6, 379-387(Dec 1975). (In Russian).

The perspects of nuclear fusion reactors utilization with the magnetic confinement of plasma are evaluated. The problems to be solved in the development of such reactors are outlined. The following laws governing the plasma confinement are assumed: neoclassical, empirical and "one hundred Bohm times". The main characteristics of hybrid reactors (Tokamaks and hybrid, open-loop, reactors) are presented. By the hybrid reactors we mean the nuclear fusion reactors which contain in their blankets uranium or thorium and which produce ^{239}Pu ot ^{233}U. The schematic diagram of a thermonuclear power plant furnished with a reactor based on the injection of fast ions is presented. The dependence of power enhancement in the plasma during a nuclear fusion reaction on the thermal efficiency of a thermonuclear power plants with reactors of different types is illustrated.

13487 Controlled thermonuclear fusion principles. Samain, A. (Commis a l'Energ At, Fr). *Entropie;* **11**: No. 61, 5-9(1975). (In French with English abstract).

The achievement of nuclear fusion for industrial energy production is only possible if the reacting nuclei have a "thermonuclear" temperature at least equal to 10^8 °K. The experimental work follows mainly two lines; The first one consists of irradiating a small dense pellet by giant laser pulses so that nuclear reactions take place significantly before the matter be dispersed. Another possibility relies upon the concept of magnetic trap where the thermonuclear temperature could be maintained by the energy released by the nuclear reactions.

13488 Problems in realizing a thermonuclear reactor. Bonnal, J.F.; Leloup, C. (Assoc Euratom-CEA Sur la Fusion, Cent d'Etud Nucl, Fontenay-Aux-Roses, Fr). *Entropie;* **11**: No. 61, 10-24(1975). (In French with English abstract).

The physics of plasma production and confinement is in constant progress and the production of a thermonuclear plasma would appear to be feasible in the near future. The main technical problems to be solved before the achievement of an economical thermonuclear reactor are reviewed. The principal characteristics of a thermonuclear plasma are discussed in part 2; in particular, the main dimensions and power level are deduced. Part 3 is devoted to the description of a toroidal confinement reactor of the Tokomak type. Finally, some characteristics of laser fusion (Part 4) and other reactor models (Part 5) are discussed briefly.

13489 Plasma in the tokamak. Artsimovitch, L.A. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 1, 1-7(1972).

The following areas are briefly discussed: the actual known plasma properties in tokamaks, the improvement of existing experimental data, correlation between theory and experiment, and the prediction of plasma properties in larger installations.

13490 Association Euratom-FOM: scientific program of controlled thermonuclear research for the years 1971-1975. Braams, C.M. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 6, 189-194(1972).

Research carried out under the program is reviewed and future development discussed.

13491 Scaling of tokamaks. Englemann, F.; Enriques, L. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 5, 155-161(1972).

The scaling up of tokamaks to performance close to the thermonuclear regime is discussed within the framework of the classical model.

13492 Scaling of wall-stabilized scyllac experiments. Freidberg, J.P.; Ribe, F.L. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 5, 163-168(1972).

The scaling laws based upon existing theory are investigated and their implication for future experiments such as a scientific feasibility experiment examined.

13493 Fusion research program of the Federal Republic of Germany. Pfirsch, D.; Von Gierke, G. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 6, 203-214(1972).

In the Federal Republic there are mainly two Institutes engaged in fusion research, i.e., Max-Planck-Institut fur Plasmaphysik (IPP) at Garching, Munich, and Institut fur Plasmaphysik der Kernforschungsanlage (KFA) at Julich. Both Institutes are associated with Euratom. In the last few years, the program has concentrated on key problems of plasma physics connected directly with the development of a fusion reactor.

BLANKET ENGINEERING

REFER ALSO TO CITATION(S) 13522

13494 (ANL/FPP—77-1, pp 51-89) **Fusion systems engineering.** Abdou, M.A.; Stacey, W.M. Jr. 1977.

In Fusion power program quarterly progress report, January—March 1977.

The following areas of research are described: (1) trade-offs in β/sub t/, magnetic field, and reactor power, (2) thermal hydraulic and power cycle subsystems analyses, (3) plasma subsystem analyses, (4) reactor plasma driving subsystem analyses, (5) lithium processing test loop, (6) molten salt reprocessing, (7) lithium mini test loop studies, (8) EPR containment building overpressure resulting from rupture of pressurized water system, (9) lithium fire analysis, (10) analysis of tritium soaking mechanisms, and (11) effect of a Tokamak plasma quench on the EF and OH coils and power supplies. (MOW)

13495 (INIS-mf—3663, pp 42-44) **^{233}U blanket calculations for a laser-fusion reactor.** Krumbein, A.D.; Lemanska, M.; Yiftah, S. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center); Wagschal, J.J.; Yaari, A. (Hebrew Univ., Jerusalem (Israel). Racah Inst. of Physics). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13496 (Juel—1357) **Test of calculational methods for the neutron physics of lithium-blanket models for a fusion reactor. Thesis.** Herzing, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Dec 1976. 139p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Calculations of the most important parameters of a blanket model of a thermonuclear reactor are carried out. The neutron distribution and the tritium production rates are calculated using discrete ordinates and Monte Carlo methods. Several estimators for the neutron statistics of Monte Carlo calculations are discussed. A comparison between the calculated and measured tritium breeding rate and space dependent tritium production rate is made. A sensitive study of the reaction cross section producing tritium follows. It is shown that a good agreement between the results of the Monte Carlo calculations and the measurements can be achieved taking into account the uncertainties of the nuclear data used for the calculations. Neutron spectra in the high energy range were measured by threshold detectors. The neutron spectra are evaluated by an unfolding program. Finally similar investigations are carried out with the lithium blanket model extended by a 15 cm thick graphite reflector and an inner 4.5 cm thick beryllium layer.

13497 Thermal-hydraulic analysis of low activity fusion blanket designs. Fillo, J.A.; Powell, J.; Yu, W.S. (Brookhaven Natl Lab, Upton, NY). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-85, 1-8(1977).

Design studies of minimum activity fusion blankets have led to a variety of designs which depend on different heat transfer mechanisms as the dominant means of cooling and, in some cases,

transporting heat through the blanket to the heat sink. In this paper, the focus is on the heat transfer aspects of fusion blankets where: (a) conduction and (b) boiling and condensation are the dominant heat transfer mechanisms. The conduction cooled blanket is formed out of SAP hexagonal rods welded or brazed onto a number of aluminum alloy plates which are fixed to the primary shield. The plates are cooled by separate, redundant water cooling circuits. The second option makes use of a themosyphon as a means of removing and transporting heat from the blanket to a heat sink. 8 refs.

MAGNET COILS AND FIELDS

13498 (IPP—2/231) **Magnetic surfaces of the W VII A stellarator.** Jaeckel, H.J.; Kisslinger, J.; Rau, F. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Aug 1976. 28p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Properties of the magnetic field of the Garching stellarator WENDELSTEIN VII A are studied experimentally, using a pulsed electron beam at reduced magnetic fields. Nested magnetic surfaces are shown to exist within the limiter radius, for values of the rotational transform t approximately 0.25. Up to t = 0.72 the shape of the experimental magnetic surfaces is nearly identical to that of computed surfaces, and computed values of rotational transform agree within a few % with the experiment. As expected for for a l = 2 stellarator, the shear is small; d(rotational transform)/dr > 0. Analytic approximations are derived for various relationships between the currents in the field systems, the rotational transform and the radial coordinate. Stray radial and vertical fields present in the installation are inferred from experiments without helix current and from the observed shift of the magnetic axis. They appear to be mainly proportional to, and amounting to about 0.4% of, the toroidal field. For an irrational rotational transform approximately 0.23, an applied local and predominantly radial field of up to 2% of the toroidal field shifts the magnetic axis and changes rotational transform, but does not destroy the configuration. For a rational rotational transform, magnetic islands could not be identified experimentally. They are calculated to exist with a radial dimension of about 20% of the limiter radius, caused by certain construction elements of the helix conductors. An increased shear, which would be produced by a torsatron configuration in W VII A, would reduce the size of these islands.

13499 (ORNL/TM—6075) **Effects of global field errors on ELMO Bumpy Torus.** Quon, B.H.; Dandl, R.A.; Colestock, P.L.; Ikegami, H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1977. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

The plasma sensitivity to magnetic field error effects has been tested experimentally using externally introduced global field errors in the ELMO Bumpy Torus (EBT). A critical field (delta B/sub r// B)/sub cr/ approximately 0.6-1 x 10^{-3} was observed, below which the plasma is essentially free from convective cells, toroidal currents, and instabilities. The observed critical value is comparable to a neoclassical critical field error (delta B/sub r//B)/sub cr/ approximately equal to rho/R, the ratio of the ion Larmor radius to the major radius of the torus.

13500 (UCRL—79723) **Cold-pressure-welded joints in large multifilamentary Nb—Ti superconductors.** Cornish, D.N.; Deis, D.W.; Zbasnik, J.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Sep 1977. Contract W-7405-ENG-48. 6p. (CONF-771029—41). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A number of mechanical and electrical measurements were made on joints in typical conductors for the proposed mirror fusion test facility (MFTF) and high field test facility (HFTF). For such measurements, a commercially available cold-pressure-welding machine was used. For joints in the MFTF conductor, which has a large proportion of superconductor, joint strength approached conductor strength. For the HFTF conductor, where the Cu-to-superconductor ratio is 4.33/1, the joint is stronger than the conductor. Electrically, the joints were not superconducting.. While the resistance is higher than might be achieved by other forms of joining, we feel that the cold-weld joint has the advantages of simplicity, speed, reliability, and reproducibility. This makes the method attractive for MFTF, where resistance losses will be small compared with the total 4 K refrigeration requirements.

13501 (UCRL—79724) **Strain-critical current data for large multifilament Nb_3Sn conductors.** Deis, D.W.; Cornish, D.N.; Hirzel, D.G.; Rosdahl, A.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Oct 1977. Contract W-7405-ENG-48. 5p. (CONF-771029—57). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

Strain-critical current measurements of monolithic, multifilament Nb_3Sn conductors are extended to larger conductors carrying approximately 3.5 kA at 12 T. Measurements were made under pure tension up to 0.9 percent strain and under combined tensile (up to 0.36 percent) and bending (+-0.53 percent) strain. Our results came close to those obtained previously on smaller (1 to 2 kA) conductors. These latest data served as our basis to design a prototype 5-kA, 12-T conductor for a 40-cm-bore magnet.

13502 **Eight coil superconducting torus for elastic buckling studies.** Moon, F.C.; Swanson, C.; King, S. (Cornell Univ., Ithaca, N.Y. (USA)). *Cryogenics;* 17: No. 6, 341-344(Jun 1977).

Elastic structural analysis of proposed fusion reactors suggests that without sufficient lateral constraints the toroidal magnets could suffer a buckling deformation. To model such effects a small, flexible 32 kA, eight coil superconducting torus has been built and tested. Test results show the predicted buckling behaviour at current below the normal-superconducting transition.

13503 **Generation of field-reversing E layers with millisecond lifetimes.** Davis, H.A.; Meger, R.A.; Fleischmann, H.H. (Cornell Univ., Ithaca, NY). *Phys. Rev. Lett.;* 37: No. 9, 542-545(30 Aug 1976).

Field-reversing electron rings, exhibiting initial axial field changes deltaB/B/sub z0/ less than or equal to 170 percent, and having overall lifetimes of greater than 1300 μsec, have been generated by injection of 2.1-MeV, 30-kA electron-beam pulses into the relativistic-electron-coil-experiment (RECE)-Christa mirror field, B/ sub z0/(z). These lifetimes, which are comparable with those expected from collisional diffusion of the fast electrons, constitute an improvement of more than a factor of 40 over the earlier results from RECE-Berta.

13504 **Toroidal line cusp theory at Princeton.** Boozer, A.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). pp 387-390 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A program of theoretical research is being carried out at Princeton on the toroidal line cusp (or tormac) concept. There is an experimental program under Dr. M.A. Levine at the Lawrence Berkeley Laboratory. In this paper we will review the theory of tormac and briefly outline the Princeton program.

13505 **Experimental observations of the self reversal of toroidal magnetic field in pinches.** Butt, E.P.; Newton, A.A.; Verhage, A.J.L. (UKAEA Research Group, Abingdon. Culham Lab.). pp 419-423 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Observations of the generation of enhanced axial flux leading to the self reversal of toroidal magnetic field in three different experiments, HBTX, FRSX and ZETA, are summarised and compared with theoretical predictions.

13506 **Finite wavelength stability of the bumpy theta pinch.** Cayton, T.E.; Vahala, G. (College of William and Mary, Williamsburg, Va. (USA). Dept. of Physics). pp 295-299 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The stability of the bumpy theta pinch is of importance, not only because of its relevance to the Scyllac experiment but also because in any magnetic confinement scheme the use of (discrete) magnetic coils necessarily introduces bumpiness in the applied field. The long wavelength stability has been considered by Weitzner who performed a double perturbation expansion on the linearized equations of ideal MHD: first in epsilon (characterizing the long wavelength or the modes) then in delta (characterizing the bumpiness of the field lines). The stability of the finite wave-length modes by expanding (only) in the small bumpiness parameter delta is examined. Currents flow only in the ignorable theta direction.

13507 **Evolution of reversed field pinch configurations.** Christiansen, J.P.; Roberts, K.V. (UKAEA Research Group, Abingdon. Culham Lab.). pp 317-321 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The time evolution of a RFP confinement model from the initial Taylor state is calculated using the ATHENE 1 equilibrium and diffusion code. It is assumed that non-classical transport and energy generation is confined to Suydam-unstable regions. The plasma develops an inner anomalous core extending to about half the radius, surrounded by an outer classical layer responsible for confinement. The effect of the anomalous transport is to flatten the pressure profile and somewhat reduce the temperature, βsub(theta), and containment time but no undue degradation of performance is observed. The results are independent of the transport rate when this is sufficiently fast. Further work is needed to check the validity of the model.

13508 Reversed field configurations with minimum potential energy. Ortolani, S.; Rostagni, G. (Centro di Studio sui gas Ionizzati, CNR-Universita di Patova, (Italy)). pp 335-339 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Theoretical and experimental results show that a stabilized pinch in a flux conserving shell tends to generate a reverse field configuration (self-reversal) when the pinch ratio THETA=Bsub(theta wall)/Bsub(z average) is large enough. We discuss here some very simple calculations based on a sharp boundary model. The potential energy of the system is evaluated for the different equilibrium states, with the constraint of a constant longitudinal magnetic flux phisub(z). If the equilibria of the minimum energy for any given THETA are considered, the result is that they correspond to a reverse field configuration (negative values of the parameter Z = Bsub(z wall)/Bsub(z average)) when THETA > THETAsub(c). The dependence of the potential energy and THETAsub(c) on Bsub(theta) is also evaluated. The case of a current sheet with finite thickness is finally examined.

13509 Hybrid model studies of magnetic field diffusion in high-β pinches. Sgro, A.G.; Nielson, C.W. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 329-334 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

We have devised a hybrid model which includes all nontrivial field components and an anisotropic anomalous resistivity, and have applied it to the ZT-1 reverse field diffuse pinch. For a proper choice of anomalous resistivity, the calculated and observed fields are in good agreement. Impurities are found to cause the plasma to implode to a smaller radius and to result in lower electron temperatures and higher ion temperatures.

13510 Equilibrium and stability of theta-pinch plasma in modified toroidal multiple mirror field. Shiina, S.; Saito, K.; Osanai, Y.; Itagaki, T.; Karakizawa, T.; Gesso, H.; Todoroki, J.; Kawakami, I.; Yoshimura, H. (Nihon Univ., Tokyo). pp 147-153 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

To confine a high-beta plasma a new toroidal magnetic configuration with closed lines of force has been proposed. The configuration is an appropriate superposition of l = 0, l = +- 1, l = +- 2,sup(...), helical fields. In this experiment, it is generated by modifying the multiple mirror field by enclosing the discharge tube in a copper shell which has longitudinal gap. This configuration is preferred for the wall stabilizing effect to that with the separated helical windings. The characteristics of the equilibrium conditions are examined based on the near-axis approximation theory and compared with the experimental results. The stability of plasma in the configurations with l = 0 field and with superposition of l = 0, l = +- 2 fields is investigated in linear geometry.

13511 Magnetic topography of toroidal systems. Skoblik, M.N.; Ziser, V.E.; Georgievskii, A.V.; Peletminskaya, V.G. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **19**: No. 10, 1277-1280(Apr 1975).

Magnetic fields of toroidal systems are calculated, taking account of the finite size of the elements producing the field. The rule for locating the helical windings on the surface of the torus is discussed in general form, yielding the choice of the optimum pitch for a given device. An algorithm is developed and a computer program is given for calculating the field at any point in space from a single helix or a set of n-helical windings. Results for specific thermonuclear devices are presented. 8 refs.

13512 Steady state toroidal pinches. Bickerton, R.J. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 3, 95-110(1972).

Several conceptual schemes have been suggested for running toroidal pinches in a steady state. A pinch is taken to mean any containment system in which a poloidal field (B-theta) produced by a plasma current is an essential feature of the containing magnetic field. Both tokamaks and diffuse pinches come into this category. In all existing experiments the current is pulsed, produced by the transformer action of a changing magnetic flux through the central region of the torus. Schemes for maintaining the toroidal current (I-phi) in steady state are reviewed. The main results are re-derived and critically assessed.

POWER SUPPLIES, ENERGY STORAGE

13513 (ANL/FPP—77-1, pp 90-100) **Magnetic systems.** Fuja, R.; Kustom, R.L.; Smith, R.P.; Wehrle, R. 1977.

In Fusion power program quarterly progress report, January—March 1977.

Research progress is reported on each of the following areas: (1) energy storage and transfer system, (2) ion sources, and (3) negative ion source development. (MOW)

13514 (LA-UR—77-2407) **Air driven fiber optic coupled pulser system for ZT-40.** Nunnally, W.C.; Brousseau, A.T. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 4p. (CONF-771029—35). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

The design, construction, and operation of an air powered fiber optic coupled pulser system for initiating various high-voltage systems in the ZT-40 experiment is displayed. The air fiber optic system provides complete electrical isolation of the experimental high-voltage circuits from the digital timing and control circuits. In addition, this pulser system prevents cross talk between individual output channels and eliminates trigger system ground loops. The system uses an additional fiber optic bundle to confirm pulser output in the screen room.

13515 (UCRL—79594) **Design of an eight-megawatt series regulator.** DeVore, K.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Oct 1977. Contract W-7405-ENG-48. 5p. (CONF-771029—58). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

An 8-MW, 100 percent duty cycle, hard tube series regulator used to control the accelerating voltage of a neutral beam source is described. The series tube is a developmental switch/regulator tube capable of holding off 200 kV passing 85 A, and dissipating 2 MW of anode power. The regulator has high-speed interrupt capability to minimize the power delivered to the load in the event of a load fault. Its design is such that it can be used to regulate both positive and negative accelerating voltages. All reference/control signals between the modulator and the control station use optical links to minimize noise interference and ground loop problems. In all cases of optical coupling, the loss of light is the worst-case condition, i.e., loss of light turns off the regulator. The fast interrupt is accomplished by rapid removal of the screen grid voltage from the series tube, and then driving the control grid into cutoff. After the control grid is in cutoff the screen is allowed to recover, and the regulator is then ready to switch back on. The regulator tube driver is a straightforward dc-coupled amplifier with a cathode follower output; dc isolation between various sections of the modulator is accomplished by using optical coupling. The use of optics allows the use of solid-state devices in an extremely hostile environment containing both electromagnetic and nuclear radiation.

13516 (UCRL—79611) **Analysis of three-phase power-supply systems using computer-aided design programs.** Oberst, E.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1977. Contract W-7405-ENG-48. 8p. (CONF-771029—59). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A major concern of every designer of large, three-phase power-supply systems is the protection of system components from overvoltage transients. At present, three computer-aided circuit design programs are available in the Magnetic Fusion Energy (MFE) National Computer Center that can be used to analyze three-phase power systems: MINI SCEPTRE, SPICE I, and SPICE II. These programs have been used at Lawrence Livermore Laboratory (LLL) to analyze the operation of a 200-kV dc, 20-A acceleration power supply for the High Voltage Test Stand. Various overvoltage conditions are simulated and the effectiveness of system protective devices is observed. The simulated overvoltage conditions include such things as circuit breaker openings, pulsed loading, and commutation voltage surges in the rectifiers. These examples are used to illustrate the use of the computer-aided, circuit-design programs discussed in this paper.

13517 (UCRL—79693) **Regulated 15-V, 7500-A, neutral-beam filament supply.** Reass, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Sep 1977. Contract W-7405-ENG-48. 5p. (CONF-771029—50). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

Lawrence Livermore Laboratory (LLL) designed a cost-effective, regulated 15-V, 7500-A filament supply for use with the High-Voltage Test Stand , a major ERDA developmental neutral-beam test facility. The filament supply can float to 200 kV and can provide pulse widths up to 30 s. Powered by a 24-V, 0.5-TJ battery bank, it avoids the use of expensive isolation transformers and induction voltage regulators (IVR's). Battery output is regulated by a water-cooled resistor-contactor combination in which contactors are closed in sequential format to create a staircase current waveform. A fine-tuning network tunes in-between the "steps" for regulation to less than 0.5 percent. The regulator is digitally controlled except for the sense amplifiers, which are optically coupled to the digital controller. All ground telemetry uses optical links to minimize effects of rfi and emi noise in the data channels.

13518 (WFPS-TME—019) **TFTR generator load assessment.** Heck, F.M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EX-76-C-02-3073. 52p. Dep. NTIS, PC A04/MF A01.

Typical experimental load demands on the TFTR generators are illustrated based on the electrical characteristics of the field coils, the coil leads, the main bus work, the various auxiliary bus work, the rectifiers, and transformers. The generator MW capacities are shown to be adequate for the proposed experimental operations with allowances made for variations in the final designs. The generator MVA capacities are shown to be adequate provided portions of the TF and EF rectifiers are freewheeled at selected times.

13519 High-energy pulsed power plants for nuclear fusion experiments. Vau, G. (Siemens A.G., Erlangen (Germany, F.R.). Bereich Verkehr und Oeffentliche Auftraggeber). *Siemens Rev.;* **43**: No. 6, 236-242(Jun 1976).

Pulsed plasma machines operating on the stellarator and tokamak principles form major steps in the development of nuclear fusion reactors. These machines require high-energy pulsed-power plants. The largest such plant in the world has now been installed at the Max Planck Institute for Plasma Physics (IPP) in Garching, Bavaria. It incorporates a flywheel m.g. set for a peak output of 150 MW and useful energy of 1450 MWs.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 13494, 13497

13520 (ANL/FPP—77-1, pp 27-36) **Experimental power reactor.** Stacey, W. Jr. 1977.

In Fusion power program quarterly progress report, January—March 1977.

Research conducted during this period is reported for the following areas: (1) revised EPR design, (2) power requirements for ignition and beam driven burn, (3) magnet systems, (4) vacuum systems, and (5) thermal hydraulic analysis. (MOW)

13521 (PPL—1380) **Feasibility study of LiF-BeF_2 and chloride salts as blanket coolants for fusion power reactors.** Imamura, Y. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Sep 1977. Contract EY-76-C-02-3073. 56p. Dep. NTIS, PC A02/MF A01.

The feasibility of using molten salts, in particular, nonberyllium-bearing chloride salts, as blanket coolants for Tokamak fusion reactors has been examined for the nucleonic and thermal/hydraulic aspects. It is concluded that the chloride salts, i.e., LiCl—KCl, LiCl—$PbCl_2$ and LiCl—$SnCl_2$, can be used as the blanket coolant for a static lithium metal blanket provided that large blanket thickness can be tolerated, along with the use of U-238 for neutron multiplication in the cases of LiCl—KCl or LiCl—$SnCl_2$ cooled blankets. However, to make the appraisal complete, the tritium recovery and corrosion problems must be examined extensively, based on data not yet at hand. As for LiF—BeF_2, it is observed that although the salt mixture can be used for a single fluid blanket with satisfactory nuclear performance, careful attention should be paid to the cooling capability.

13522 Two-phase-flow cooling concept for fusion reactor blankets. Bender, D.J.; Hoffman, M.A. (Lawrence Livermore Lab, Calif). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-86, 1-12(1977).

Boiling potassium is considered to be a potentially attractive coolant for high-temperature fusion reactor blankets. The problem of the magnetic pressure drop experienced by the inlet liquid potassium flow can be eliminated by employing a proposed two-phase mist-flow mixture of liquid potassium droplets and helium gas. The flow regime parameters necessary to accomplish this are estimated in this paper, and some key experiments necessary to verify the feasibility of the concept are identified. 28 refs.

13523 Approach for determining the impact of peak coolant temperature on fusion reactor size and electricity costs. Bowers, D.A. (McDonnel-Douglas Astronaut Co.-East St. Louis, Mo). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-73, 1-7(1977).

This paper addresses the impact of blanket coolant outlet temperature (peak coolant temperature) on controlled thermonuclear reactor size as measured by thermal power output and electrical power costs. The UWMAK-III reactor is used as a reference design for which the thermal converson efficiency effects of peak coolant temperatures in the 500 to 1000 C range are assessed. Required reactor thermal power is seen to vary no more than 11 percent among the three reference peak coolant temperatures. The cost of electricity also shows a relative insensitivity to peak coolant temperature and indicates that a steam cycle conversion system is preferable to a high temperature closed cycle gas turbine system. 6 refs.

13524 Thermal hydraulic and power cycle analysis of liquid lithium blanket designs. Misra, B.; Stevens, H.C.; Maroni, V.A. (Argonne Natl Lab, Ill). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-84, 1-11(1977).

Thermal hydraulic and power cycle analyses were performed for the first-wall and blanket systems of tokamak-type fusion reactors under a typical set of design and operating conditions. The analytical results for lithium-cooled blanket cells show that with stainless steel as construction material and with no divertor present, the maximum allowable neutron wall loading is limited by thermal stress criteria. With vanadium alloy as construction material and no divertor present, the maximum allowable neutron wall loading is limited by an interplay of constraints imposed on the maximum allowable structural temperature and the minimum allowable coolant inlet temperature. The cost of the vanadium system is found to be competitive with the stainless steel system. 16 refs.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 13275, 13517

13525 (GA-A—14475) **Review of hybrid reactor fuel cycle considerations.** Schultz, K.R. (General Atomic Co., San Diego, Calif. (USA)). Jul 1977. Contract EY-76-C-0167-038. 24p. (CONF-770350—2). Dep. NTIS, PC A02/MF A01.

From US/USSR workshop on hybrid reactor design; Moscow, USSR (14 Mar 1977).

A review of the fuel cycle considerations of hybrid (fusion-fission) reactors was carried out to compare the uranium and thorium fuel cycles from the point of view of hybrid reactor application. Included in the review are the energy production and fuel production aspects of uranium and thorium blankets as well as the resource availability and materials capabilities of uranium and thorium fuels. The characteristics of the ^{233}U bred in thorium hybrid blankets and the plutonium bred in uranium hybrid blankets were examined. Important considerations are the fuel isotopics, fuel and waste toxicity, and reprocessing and refabrication aspects of hybrid reactor blankets. The values of the bred fuel products of thorium and uranium blankets are compared and the results of systems economic studies using thorium and uranium hybrid blankets are summarized. On the basis of these fuel cycle reviews, the relative advantages and disadvantages of uranium and thorium for use in hybrid reactors can be compared. The uranium cycle may allow easier hybrid reactor design due to its higher fast fission rate. The thorium cycle produces a much better fuel. Practical fuel cycle concerns appear equally manageable for both cycles, and their economics can be about the same. It is concluded that both thorium and uranium fuel cycles are attractive for use in hybrid reactors and both should be pursued in the course of hybrid reactor system studies.

13526 (INIS-mf—3663, pp 40-41) **Further studies of fission-fusion symbiosis in highly compressed microspheres.** Krumbein, A.D. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13527 Self magnetic insulation of pulsed ion diodes. Humphries, S. Jr. (Cornell Univ., Ithaca, N.Y. (USA). Lab. of Plasma Studies). *Plasma Phys.;* **19**: No. 5, 399-406(May 1977).

Pulsed ion diodes magnetically insulated by their own feed currents can be treated in a manner similar to that used for applied field diodes. The self insulated diode has the advantages of easy construction and automatic confinement of the magnetic field to the accelerating gap, but the energy that produces the magnetic field is utilized inefficiently. With models for the ion current density, it is possible to calculate the optimum electrode shapes of ion diodes to produce a spherical focus. In this application it is shown that the pinched electron diode may not be the most advantageous self insulated geometry.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 13494

13528 (UCRL—79718) **Engineering of beam direct conversion for a 120-kV, 1-MW ion beam.** Barr, W.L.; Doggett, J.N.; Hamilton, G.W.; Kinney, J.D.; Moir, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1977. Contract W-7405-ENG-48. 9p. (CONF-771029—47). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

Practical systems for beam direct conversion are required to recover the energy from ion beams at high efficiency and at very high beam power densities in the environment of a high-power, neutral-injection system. Such an experiment is now in progress

using a 120-kV beam with a maximum total current of 20 A. After neutralization, the H^+ component to be recovered will have a power of approximately 1 MW. A system testing these concepts has been designed and tested at 15 kV, 2 kW in preparation for the full-power tests. The engineering problems involved in the full-power tests affect electron suppression, gas pumping, voltage holding, diagnostics, and measurement conditions. Planning for future experiments at higher power includes the use of cryopumping and electron suppression by a magnetic field rather than by an electrostatic field. Beam direct conversion for large fusion experiments and reactors will save millions of dollars in the cost of power supplies and electricity and will dispose of the charged beam under conditions that may not be possible by other techniques.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 12945

13529 (SAND—77-1506C) **Electron beam driven implosions.** Baker, L.; Clauser, M.J.; Freeman, J.R.; Mix, L.P.; Olsen, J.N.; Perry, F.C.; Toepfer, A.J.; Widner, M.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 21p. (CONF-771035—13). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, NY, USA (3 Oct 1977).

Theoretical and experimental investigations have been carried out to study the physics of electron beam driven targets with emphasis on implosion dynamics and stability.

13530 (SAND—77-1548C) **REB propagation and combination in plasma channels.** Miller, P.A.; Baker, L.; Freeman, J.R.; Mix, L.P.; Poukey, J.W.; Wright, T.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 12p. (CONF-771035—18). Dep. NTIS, PC A02/MF A01.

From 2. international topical conference; Ithaca, NY, USA (3 Oct 1977).

An attractive approach to pellet fusion involves the use of many independently generated pinched REBs which are transported to and combined at a target. Results of theoretical and experimental investigations into various aspects of the problem are presented.

13531 **Ponderomotive force, magnetic fields and hydrodynamics of laser produced plasmas.** Bobin, J.L. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)); Wee Woo; Degroot, J.S. (California Univ., Davis (USA)). *J. Phys. (Paris);* **38**: No. 7, 769-782(Jul 1977). (In French).

Nonlinear effects deeply change the structure of a laser driven plasma flow. For high intensities, the radiation pressure should be taken into account. It acts through a ponderomotive force proportional to the electron density and to the gradient of the mean electric field energy density of the incident wave. Static magnetic fields originate from a term in the ponderomotive force which includes radiation absorption and whose curl is non zero. The basic properties of the structure are determined analytically in the absence of thermal conductivity and magnetic fields: steep density gradient close to the cut-off density, shelf at lower densities. The conditions of a steady state regime are set up. The isothermal case is specially investigated. It is shown that the cavities which are created in a motionless plasma may disappear due to the onset of a flow. Regions in which electromagnetic forces arising from the static field compensate the ponderomotive force are determined. The subsequent effects on the flow itself are studied.

13532 **Comment on resonant absorption.** Hammerling, P. (KMS Fusion, Inc., Ann Arbor, Mich. (USA)). *Plasma Phys.;* **19**: No. 7, 669-675(Jul 1977).

An average over angles of incidence of the usual resonant absorption function is presented. This form is appropriate under experimental conditions where the angles of incidence vary greatly and in an unknown manner. For comparison a lens-ellipsoidal mirror illumination system with a known longitudinal aberration is considered. In the latter example the angles of incidence are readily obtained and the resulting resonance absorption function evaluated. The associated fields are calculated in a similar fashion.

13533 **Experimental system for the study of plasmas created by laser in a gas.** Grandjouan, N.; Gauthier, J.C.; Geindre, J.P. (Paris-11 Univ., 91 - Orsay (France). Inst. d'Electronique Fondamentale). *C. R. Hebd. Seances Acad. Agric. Fr.;* **284**: No. 20, 437-440(23 May 1977). (In French).

An experimental system is described which is well suited to the spectroscopic study of dense laser-created plasmas. The space and time evolution of an atmospheric pressure helium plasma is reported.

13534 **Assessment of surface-heating problems in laser-fusion reactors.** Abdel-Khalik, S.I.; Hunter, T.O. (Univ of Wis, Madison). *Am. Soc. Mech. Eng., [Pap.];* No. 77-HT-83, 1-8(1977).

The surface-heating problems associated with the pulsed photon and ion irradiations of the first walls and liners of inertially confined fusion reactor cavities are investigated. Analytical models for predicting the thermal response of these surfaces as a function of the different design and operational parameters of the system and the nature of the incident irradiations are developed. Generalized charts are given for predicting the surface temperature rise produced by the reflected laser light and X-rays emanating from the microexplosion. Similar results are given for alpha particles (50 to 500 kev) with carbon and tantalum as collector plate materials. 9 refs.

13535 **Symmetry and stability of compression of laser thermonuclear targets.** Afanas'ev, Y.V.; Basov, N.G.; Gamalii, E.G.; Krokhin, O.N.; Rozanov, V.B. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Eksp. Teor. Fiz., Pis'ma Red.;* **24**: No. 11, 617-620(Jun 1976). (In Russian).

13536 **Spectra and absolute yield of charged particles arising due to a fusion reaction under laser initiation.** Gus'kov, S.Yu.; Krokhin, O.N.; Rozanov, V.B. (AN SSSR, Moscow. Fizicheskij Inst.). *Kvantovaya Elektron. (Moscow);* **2**: No. 10, 2315-2324(Oct 1975). (In Russian).

Analytical results are obtained for spectra and absolute yields of charged products escaping laser plasma while undergoing the fusion. The products make it possible to diagnose such parameters of the plasma core as density, dimension and temperature. A target made of CD_2 and two possible states of plasma are considered: a compressed core of cold plasma and a compressed core of hot plasma. The action of Coulomb forces between escaping particles and a charge remaining in the core has not been taken into account in the analytical expressions obtained for spectra of secondary and primary protons. In the formulas, the temperature, density and radius of the target core correspond to parameters of the plasma core at the moment of maximum compression. The diagnostic method may be applied at the electron temperature below 50 keV, when it is possible not to consider deceleration of charged particles on plasma ions.

13537 **Averaged thermonuclear burnal wave.** Kaliski, S. (Pol Acad of Sci, Warsaw). *Bull. Acad. Pol. Sci., Ser. Sci. Tech.;* **23**: No. 2, 149-155(1975).

A simplified method for finding averaged analytic solutions is given for the problem of a burnal wave moving from the center of a D-T ball outwards as a result of concentric laser shock compression. Analytic solutions have been found for the initial phase of the process, in which hydrodynamic and other effects are negligible. It is assumed in an approximate manner that the position of the burnal wave front and the penetration depth of particles alpha are identical. 8 refs.

13538 **Laser compression of matter: optical power and energy requirements.** Kidder, R.E. (Univ of Calif, Lawrence Livermore Lab). *Nucl. Fusion;* **14**: No. 6, 797-803(Dec 1974).

The optical power P/sub L/ required to achieve a given measure of inertial confinement rhoR of a laser-compressed DT pellet is found to be approximately proportional to $(\text{rhoR})^2$. This result is based on a model of self-regulating pellet ablation by hot electrons of the pellet corona that is relatively insensitive to the details of the pellet ablation process. To achieve values of rhoR believed necessary in the application of laser fusion to commercial power production, $3*10^{15}$ W of optical power is found to be required, implying a total laser output aperture of 30 m^2. (The same power requirement would appear to apply to pellet compression by charged-particle beams.) An estimate of the required laser-pulse energy W/sub L/, assuming corona-core decoupling to be the controlling limitation, is also given. In the application to commercial power production the required pulse energy is found to range from 70 kJ at 0.265 mum to 3 MJ at 10.6 mum. 11 refs.

13539 **Symmetry of laser-driven implosions.** Henderson, D.B.; Morse, R.L. (Los Alamos Sci Lab, NM). pp 381-391 of In Laser interaction and related plasma phenonenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

A perturbation method is developed for nearly spherical heat and fluid flow. It is shown that electron thermal conduction may be sufficiently symmetrizing to allow laser-driven fusion with a single beam. 8 refs.

13540 **Laser-induced implosion and thermonuclear burn.** Nuckolls, J.H. (Univ of Calif, Livermore). pp 399-425 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenonenon conference; Troy, NY, USA (13 Aug 1973).

Fusion yields 50 to 100 times larger than the laser energy for laser energies of 10^5 to 10^6 joules have been achieved in sophisticated

computer simulation calculations. Most of the dense pellet is isentropically compressed to a high density Fermi-degenerate state, while thermonuclear burn is initiated in the central region. A thermonuclear burn front propagates radially outward from the central region heating and igniting the dense fuel. A laser fusion implosion system is described that consists of a tiny spherical pellet of deuterium-tritium surrounded by a low density atmosphere extending to several pellet radii, located in a large vacuum chamber, and a laser capable of generating an optimally shaped pulse of light energy. The atmosphere may be produced by ablating the pellet surface with a laser prepulse. Mirrors (or lenses) are used to focus the laser light on the atmosphere more or less uniformly from all sides. 22 refs.

13541 Theory and experiment in laser driven fusion. Brueckner, K.A. (KMS Fusion Inc, Ann Arbor, Mich). pp 427-447 of In Laser interaction and related plasma phenonenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

The simple model of a uniformly compressed DT sphere is used to determine the fusion energy production. Calculations of the implosion of a DT sphere in spherical symmetry show that high compression can be produced by a laser pulse with proper time variation. The efficiency of this process depends on the efficiency of energy absorption from the laser beam into the underdense plasma and on the subsequent energy partition between the compression of the dense pellet core and the energy removed in the high temperature expanding plasma produced by the ablation process. Experiments have been carried out to determine the effect of variation in the laser and pellet parameters on the laser-plasma coupling.

13542 Theory of homogeneous isentropic compression and its application to laser fusion. Kidder, R.E. (Univ of Calif, Livermore). pp 449-464 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

The hydrodynamic theory and properties of spherical homogeneous isentropic compression are discussed. Computer results are described showing that a close approximation to compressions of this type may be accomplished by light-induced pellet ablation if the light absorbed by the pellet is properly programmed with time, and is spatially uniform over the pellet surface. Pellet compressions in excess of ten thousand-fold are computed. 9 refs.

13543 Laser compression and fusion of plasma. Kaliski, S. (Pol Acad of Sci, Warsaw). pp 495-517 of In Laser interaction and related plasma phenomeno conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

A short review of works on laser concentric heating and compression of plasma, from the point of view of nuclear fusion, has been given. Then different variants of approximate, averaged description for a D-T sphere submitted to the concentric laser compression by taking into account the recovered fusion heat, are considered. Among others, the integral similarity model is discussed for the kernel of the D-T sphere (Fermi liquid) and the expanding outer layer (two-temperature plasma). Averaged description taking into account the fronts of thermal and shock waves are also proposed. The idea of explosive precompressing of laser compression of plasma is suggested, which allows the critical laser pulse to be reduced by 2 to 3 kJ. 74 refs.

13544 Laser produced plasmas with fissionable material. Winterberg, F. (Univ of Ne Syst, Reno). pp 519-535 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

The compression of a pellet consisting of fissionable material, such as U233, U235 or Pu239, to high densities by a laser-(or possibly relativistic electron-) beam induced implosion, will lead to very small critical masses. The critical mass can be furthermore substantially reduced by simultaneously compressing the pellet together with a neutron reflector. By this method micro-fission--explosions can be triggered which can be used for controlled power production as for a safe fast breeder reactor or for rocket propulsion. In addition, if the neutron reflector consists of thermonuclear material, such as T-D, the controlled release of thermonuclear energy becomes possible. In this case the fission chain reaction not only will assist in the ignition of the thermonuclear reaction but in turn the neutrons released in the fusion process will accelerate the fission chain reaction to a very fast pace. 7 refs.

13545 Super-compression of fissionable material by lasers. Rabinovich, M.S.; Askarjan, G.A.; Namiot, W.A. (P.N. Lebedev Phys Inst, Moscow, USSR). pp 537-541 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

It is proposed to use super-high compression of heavy hydrogen under the action of high intensity light to solve the problem of production of microscopic critical masses of fissionable heavy elements. 5 refs.

13546 Observation of the laser-induced compression wave in a solid target. Van Kessel, C.; Sigel, R. (Max Planck Inst fuer Plasmaphys, Garching, Ger). pp 547-552 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

The evolution of the compression wave which forms on laser impact on a plane solid target has been followed by streak- and framing photography. Using known Hugoniot-data a peak pressure of 2.5 Mbar and a density increase $rho/rho_0=2.3$ has been measured in plexiglass. The study of this phenomenon is of interest with respect to laser fusion applications and because it opens new possibilities in studying the properties of matter under extremely high pressures. 7 refs.

13547 Thermonuclear fusion plasma heated by lasers. Yamanaka, C.; Yamanaka, T.; Kang, H. (Osaka Univ, Jpn). pp 629-665 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

The interaction between laser and plasma has been investigated using YAG-glass and glass-glass laser systems and a solid hydrogen and deuterium target. The latter, broad-band laser system was much more effective for heating. This might be attributed to a double resonance absorption. Induced back scattering of SHG and Brillouin is studied. Isotope effect of the ion wave is observed. In an appendix, the properties of high power disc laser and the results of a computer experiment on pellet compression are presented. 17 refs.

13548 Laser-matter interaction studies at NRL. Stamper, J.; Barr, O.C.; Davis, J.; Doschek, G.A.; Dozier, C.M.; Feldman, U.; Klein, B.M.; Manheimer, W.M.; McLean, E.A.; McMahon, J.M.; Nagel, D.J.; Tidman, D.A.; Whitlock, R.R.; Whitney, K.; winsor, N.K.; Young, F.C. (Nav Res Lab, Washington, DC). pp 713-754 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

Experimental and theoretical studies are descrbed that are directed toward understanding the interaction of a focused, high-brightness laser pulse with a solid target. The physics of laser-fusion and efficient x-ray generation are of particular interest. A Nd-doped, YAG-glass laser system is used which has rod and disc amplifiers and protection against back-reflected pulses. Experimental studies include x-ray emission, neutron production, magnetic field generation and back-reflected laser light. Theoretical studies include both analytic and numerical treatments of radiation emission and transport, magnetic field dependent plasma transport phenomena and the role of magnetic fields in plasma collective effects. 32 refs.

13549 Some reactor implications of laser fusion. Spalding, I. (UKAEA Culham Lab, Abingdon, Berks, Engl). pp 775-796 of In Laser interaction and related plasma phenomenon conference. New York; Plenum Press (1974).

From 3. laser interaction and related plasma phenomenon conference; Troy, NY, USA (13 Aug 1973).

Some technological aspects of blanket design, operating frequency, and pellet production in a laser-compression reactor are discussed. Economic implications of the concept are then reviewed. Assuming electrical pumping of the laser system, it is important to minimize the circulating power by using very efficient lasers and achieving a high burn up in the compressed core. The desirability of a high repetition rate to allow an adequate margin in the capital cost of laser components, is demonstrated, and an estimate of typical costs for a 530 MW(e) deuterium-tritium fuelled system is presented. Economic operation of a pure DD system is shown to be much more difficult to achieve. Finally, the way in which these conclusions may be modified by alternative laser pumping techniques, and some physical factors which might affect published thermonuclear gain calculations, are summarized. 47 refs.

13550 New role for infrared lasers. Chen, F.F. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 3, 81-94(1972).

Aside from plasma diagnostics, the use of lasers in connection with controlled fusion has centered around two schemes: (1) ignition of a solid pellet by a Nd-glass or CO2 laser, and (2) heating of a gaseous plasma (produced by a theta-pinch or by the laser itself) by a CO2 laser. Development of a powerful far-infrared laser such as the HCN laser, may make possible a third application: (3) plasma stabilization in conventional confinement devices.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 13520, 13534

13551 (ANL/FPP—77-1, pp 1-26) **Fusion reactor materials.** Das, S.K.; Kaminsky, M. 1977.

In Fusion power program quarterly progress report, January—March 1977.

Data are presented for each of the following research topics: (1) plasma materials interactions, (2) alloy development for irradiation performance, (3) special purpose materials development, (4) dosimetry and damage analysis group, and (5) radiation damage in diagnostic windows. (MOW)

13552 (INIS-mf—3663, pp 54-56) **Shield optimization method based on second order perturbation theory.** Gilai, D.; Greenspan, E. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev; Ben-Gurion Univ. of the Negev, Beersheba (Israel)). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13553 (INIS-mf—3663, pp 48-50) **Optimal iron-water shields for fusion reactors.** Greenspan, E.; Levin, P. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13554 (INIS-mf—3663, pp 51-53) **Layered shield optimization with SWAN.** Levin, P.; Greenspan, E. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev; Ben-Gurion Univ. of the Negev, Beersheba (Israel)). 1976.

From Meeting of the Israel Nuclear Societies; Beersheba, Israel (23 Dec 1976).

In Transactions of the Nuclear Societies of Israel. Volume 4. Joint annual meeting 1976, Ben Gurion University of the Negev, December 23-24, 1976.

13555 (LA-UR—77-2398) **Jet target intense neutron source.** Meier, K.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 6p. (CONF-771029—38). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A jet target Intense Neutron Source (INS) is being built by the Los Alamos Scientific Laboratory with DOE/MFE funding in order to perform radiation damage experiments on materials to be used in fusion power reactors. The jet target can be either a supersonic or a subsonic jet. Each type has its particular advantages and disadvantages, and either of the jets can be placed inside the spherical blanket converter which will be used to simulate a fusion reactor neutron environment. Preliminary mock-up experiments with a 16-mA, 115 keV, H^+ ion beam on a nitrogen gas supersonic jet show no serious problems in the beam formation, transport, or jet interaction.

13556 (UCRL—79674) **Degassing a large LHe cryopump.** Denhoy, B.S.; Batzer, T.H.; Call, W.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Oct 1977. Contract W-7405-ENG-48. 6p. (CONF-771029—48). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

A method has been developed and successfully tested to degas a large LHe cryopump. Use of this method inhibits the normally excessive pressure rise during the degassing cycle when the degassing rate exceeds the external pumping capabilities of the system. A small appendage pump, installed close to the main cryopump, absorbs all the gas, as it is desorbed from the main cryopump, with no rise in the system pressure. The appendage pump can then be isolated from the main vacuum system and degassed at high pressure. We pumped 15 to 20 x 10^3 Torr . l of H_2 on a 1.25 m^2 panel. During the degassing cycle the system pressure never rose above 1 x 10^{-4} Torr. In large vacuum systems for future fusion machines that contain cryopump panels as well as cryogenic magnets, this method is a unique and very useful tool. It will allow the degassing of cryopumps without affecting the temperature equilibrium of cryogenic magnets.

13557 (UCRL—79750) **Vacuum system for the Tandem Mirror Experiment.** Atkinson, D.P.; Calderon, M.O.; Nagel, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Oct 1977. Contract W-7405-ENG-48. 7p. (CONF-771029—46). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

The Tandem Mirror Experiment (TMX) under construction at LLL is a Q-enhancement experiment using two mirror fields to "plug" a central solenoid field. Neutral beam injection supplies the energetic neutrals to the plug regions with attendant quantities of cold gas. The vacuum vessel consists of two large stainless steel tanks, which house the plug coils, joined by an aluminum central cell tank, which fits inside the existing solenoid coils from the 2XIIB experiment. The plug tanks are subdivided into regions for differential pumping of the source gas by liquid-nitrogen- or water-cooled liners. The liners are gettered by Ti—Ta wire sublimators of the 2XIIB type, using 2XIIB power supplies, to supply the necessary high-speed surface pumping. The roughing vacuum system consists of mercury vapor diffusion pumps backed by Roots-type blowers.

13558 (WFPS-TME—018) **Collection of preliminary thermal and structural calculations for TFTR components.** DeZubay, E.A.; Driesen, G. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Oct 1975. Contract EX-76-C-02-3073. 36p. Dep. NTIS, PC A03/MF A01.

Many scoping type thermal/hydraulic and structural calculations have been performed for the TFTR component conceptual designs. Five analyses are still applicable to the current October conceptual design. The analyses are for the vacuum vessel wall temperature, neutral beam calorimeter thermal response, the discharge time of the tritium line, estimate of air leakage in the TFTR Test Cell, and maximum allowable TF coil temperature. The methods of analysis and the results are presented in this report.

13559 (WFPS-TME—034) **TFTR ultrahigh-vacuum pumping system incorporating mercury diffusion pumps.** Sink, D.A.; Sniderman, M. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Jun 1976. Contract EY-76-C-02-3073. 115p. Dep. NTIS, PC A06/MF A01.

The TFTR vacuum vessel will have a system of four 61 cm diameter mercury diffusion pumps to provide a base pressure in the 10^{-8} to 10^{-9} Torr range as well as a low impurity level within the vessel. The system, called the Torus Vacuum Pumping System (TVPS), will be employed with the aid of an occasional 250°C bakeout in situ as well as periodic applications of aggressive discharge cleaning. The TVPS is an ultrahigh-vacuum (UHV) system using no elastomers as well as being a closed system with respect to tritium or any tritiated gases. The backing system employing approximately 75 all-metal isolation valves is designed with the features of redundancy and flexibility employed in a variety of ways to meet the fundamental requirements and functions enumerated for the TVPS. Since the design, is one which is a modification of the conceptual design of the TVPS, those features which have changed are discussed. Calculations are presented for the major performance parameters anticipated for the TVPS and include conductances, effective pumping speeds, base pressures, operating parameters, getter pump parameters, and calculations of time constants associated with leak checking. Modifications in the vacuum pumping system for the guard regions on the twelve bellows sections are presented so that it is compatible with the main TVPS. The bellows pumping system consists of a mechanical pump unit, a zirconium aluminum getter pump unit and a residual gas analyzer. The control and management of the TVPS is described with particular attention given to providing both manual and automatic control at a local station and at the TFTR Central Control. Such operations as testing, maintenance, leak checking, startup, bakeout, and various other operations are considered in some detail. Various aspects related to normal pulsing, discharge cleaning, non-tritium operations and tritium operations are also taken into consideration. A cost estimate is presented.

13560 **Control of electron temperature of a plasma in double plasma device.** Honzawa, T. (Utsunomiya Univ. (Japan). Faculty of Engineering). *Nippon Seirigaku Zasshi;* **42**: No. 3, 1077-1078(Mar 1977).

13561 **Technical assessment of the potentials of pulsed high-beta plasma devices as CTR radiation test facilities.** Persiani, P.J. (Argonne National Lab., Ill. (USA)). pp 599-603 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1976).

Major radiation test facilities will be necessary in the near-term (five years) and long-term (>10 years) future for the timely development and understanding of fusion confinement systems and of prototype fusion power reactors. The study includes the technical justifications and requirements for CTR Neutron and Plasma Radiation Test Facilities. It covers the areas of study needed and the plasma sources which can be used to supply the necessary radiation

levels. In particular, the dense plasma focus is examined more closely.

13562 Linear theta pinch as a 14-neutron source. Willis, W.R. (Los Alamos Scientific Lab., N.Mex. (USA)). pp 593-597 of In Pulsed high beta plasmas. Evans, D.E. (ed.). Oxford; Pergamon Press (1976).

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A linear theta pinch is considered as the neutron source in a Fusion Engineering Research Facility (FERF). The device is optimized parametrically for maximum 14-MeV neutron flux through a test sample located between the discharge tube and the compression coil wall. A flux of approximately 10^{14}n/cm^2/s can be achieved through a test-sample volume of 6.5 liters in a device 1.7 m long with a 150-kG magnetic field, 2:1 mirrors (300 kG) at the ends, a discharge frequency of 1.9 kHz, and a rotating-machinery power supply.

13563 Is a tokamak without material limiter feasible. Pfirsch, D.; Tasso, H. *Comments Plasma Phys. Controlled Fusion;* **1**: No. 5, 139-142(1972).

The effect of a limiter on the stability of a plasma in a tokamak device is considered and an experimental evaluation proposed.

GENERAL AND MISCELLANEOUS

MANAGEMENT

REFER ALSO TO CITATION(S) 13590

13564 (UCRL—52000-77-5) **Energy and technology review.** Selden, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1977. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

Topics covered include: geothermal energy development at LLL, energy conversion engineering, continuing education at LLL, and the Western states uranium resource survey. Separate abstracts were prepared for 3 sections. (MCG)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 11622, 12544

13565 (ANL-AMD-TM—259) **Introduction to the use of the LIBRARIAN in the Argonne environment.** Wenger, J. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

The use of Applied Data Research's LIBRARIAN source program retrieval and maintenance system as implemented in the Argonne environment is discussed.

13566 (ANL-AMD-TM—277) **CONTOUR.BLACKBOX: a contour mapping program.** Malon, D.M. (Argonne National Lab., Ill. (USA)). 1 Oct 1975. Contract W-31-109-ENG-38. 25p. Dep. NTIS, PC A02/MF A01.

CONTOUR.BLACKBOX is an AMD-implemented revision of a non-Argonne contouring program. It handles up to 7500 data points, and, with several control cards specifying input—output parameters, produces an appropriately formatted contour map. 6 figures.

13567 (ANL-AMD-TM—279) **Guide for the export of computer codes to the Brookhaven National Laboratory's computer facility by Argonne National Laboratory.** Bare, R.; Davis, D.; Messina, P. (Argonne National Lab., Ill. (USA)). Mar 1976. Contract W-31-109-ENG-38. 33p. Dep. NTIS, PC A03/MF A01.

Argonne National Laboratory's need for purchasing computer time from outside sources became acute in March, 1975. Contractual arrangements were established with five organizations for the use of their computing facilities. This document provides the guidelines for the export of batch jobs to the Brookhaven National Laboratory's Computer Facility.

13568 (ANL-AMD-TM—293) **Cataloged procedures for dataset transfer.** Gregory, L.A. (Argonne National Lab., Ill. (USA)). Jun 1976. Contract W-31-109-ENG-38. 44p. Dep. NTIS, PC A03/MF A01.

The group of cataloged procedures described in this technical memorandum accomplish the most frequently needed dataset transfer and creation functions. They facilitate the transfer of datasets between punched cards, sequential or partitioned disk, magnetic tape, and printed output listings. They also provide a convenient way to create (i.e., pre-allocate) sequential or partitioned disk datasets for later use. Each cataloged procedure is a set of pre-coded Job Control Language (JCL) statements that has been assigned a name and placed in a procedure library. Each procedure consists of one or more EXEC statements which define the program to be executed, followed by the data definition (DD) statements needed by the program. (RWR)

13569 (ANL-AMD-TM—294) **WYLBUR reference manual.** Krupp, R.F.; Messina, P.C.; Peavler, J.M.; Schustack, S.; Starai, T. (Argonne National Lab., Ill. (USA)). Apr 1977. Contract W-31-109-ENG-38. 149p. Dep. NTIS, PC A07/MF A01.

WYLBUR is a system for manipulating various kinds of text, such as computer programs, manuscripts, letters, forms, articles, or reports. Its on-line interactive text-editing capabilities allow the user to create, change, and correct text, and to search and display it. WYLBUR also has facilities for job submission and retrieval from remote terminals that make it possible for a user to inquire about the status of any job in the system, cancel jobs that are executing or awaiting execution, reroute output, raise job priority, or get information on the backlog of batch jobs. WYLBUR also has excellent recovery capabilities and a fast response time. This manual describes the WYLBUR version currently used at ANL. It is intended primarily as a reference manual; thus, examples of WYLBUR commands are kept to a minimum. (RWR)

13570 (ANL-AMD-TM—295) **DRAFTMAN: a routine for drawing publishable quality figures.** Gawlik, M.D. (Argonne National Lab., Ill. (USA)). Jul 1976. Contract W-31-109-ENG-38. 20p. Dep. NTIS, PC A02/MF A01.

The DRAFTMAN program is described. User—terminal interaction for figure development is outlined. Batch usage for figure plotting is specified. 5 figures.

13571 (ANL-AMD-TM—311) **LINPACK working note No. 8: three numerical experiments with Gaussian elimination.** Goodman, J.T.; Moler, C.B. (Argonne National Lab., Ill. (USA)). Jul 1977. Contract W-31-109-ENG-38. 47p. Dep. NTIS, PC A03/MF A01.

Three relatively brief papers are presented on the following subjects: element growth in Gaussian elimination, estimating cond(A) with subroutine DGECO, and consideration of an error bound in Gaussian elimination. (RWR)

13572 (ANL-AMD-TM—313) **LINPACK working note No. 9: preliminary LINPACK user's guide.** Dongarra, J.J.; Bunch, J.R.; Moler, C.B.; Stewart, G.W. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 216p. Dep. NTIS, PC A10/MF A01.

LINPACK is a collection of Fortran programs for solving various types of linear systems. The package is concerned with general, banded, symmetric indefinite, symmetric positive definite, triangular and tridiagonal square matrices, as well as with least-squares problems and the QR and singular value decompositions of rectangular matrices. The routines are designed to be completely machine independent, fully portable, and to run at near optimum efficiency in most operating environments. (RWR)

13573 (CONF-770874—1) **Error contours for Student's t under nonnormality.** Bowman, K.O.; Beauchamp, J.J.; Shenton, L.R. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.; Georgia Univ., Athens (USA)). 1977. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Proceedings of the statistical computing section-American Statistical Association; Chicago, IL, USA (15 Aug 1977).

Geary (Biometrika 34, 1947) has introduced a differential series for the density function of Student's t under nonnormality where the sample population is assumed to have finite moments up to a certain order. If [K/sub r/] and [K'/sub r/] are the cumulants of t under the two regimes (normality and nonnormality), then the discrepancies [K/sub r/—K'/sub r/] can be ordered with respect to sample size, in an ordering in powers of $1/\sqrt{n}$(n = sample size) of the modified density and cumulative distribution function of t. Geary carried this out to order n^{-2}. Relative error contours comparing Geary's n^{-1} and n^{-2} approximations of the upper and lower modified probability levels for $\alpha = 0.05$ and n = 15, 20, and 25 are given for sets of mixtures of normal distributions, and Pearson distributions, in the $(\sqrt{\beta_1},\beta_2)$ plane. Additional comparisons are given comparing these approximations from the results of a Monte Carlo simulation for a wide range of mixtures of normal distributions. 2 figures, 2 tables. (RWR)

13574 (LA—7005-MS) **Use of rank transformations in the selection of variables.** Goldman, A.; Conover, W.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Nov 1977. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

Three examples involving multivariate data are presented in which a regression analysis on the ranks of the data yields useful information concerning the selection of the best set of independent

variables. This method of analysis is compared with ordinary regression of independent variables, and the regression analysis on ranks appears to have two advantages. It furnishes consistent results in the presence or absence of outliers, while the usual regression methods select different variables when outliers are present. Also, the selection of variables using ranks agrees with the analysis of the same data augmented with a considerable amount of additional data; this agreement indicates that valid conclusions may be obtained from smaller data sets when regression methods are applied to the rank-transformed data. 5 tables.

13575 (LA-UR—77-2456) **Computer graphics for extracting information from data.** Lohrding, R.K.; Johnson, M.M.; Whiteman, D.E. (Los Alamos Scientific Lab., N.Mex. (USA)). [nd]. Contract W-7405-ENG-36. 21p. (CONF-771042—2). Dep. NTIS, PC A02/MF A01.

From 3. ERDA statistical symposium; Richland, WA, USA (26 Oct 1977).

Computer graphics which are useful for displaying and analyzing data are presented. Many classical and several newly developed graphical techniques in statistical data analysis are presented for small univariate and multivariate data sets. These include histograms, empirical density functions, pie charts, contour plots, a discriminant analysis display, cluster analysis, Chernoff "faces," and Andrews' sine curves. Recent advances in data collection technology and computer data base management systems have made it imperative to utilize computer graphics for large data sets. Several innovative graphical techniques are presented to handle this situation. Spatial relationships among the data (particularly geographic data) are difficult to conceptualize. Several cartographic techniques are presented which enhance the understanding of these spatial relationships within the data.

13576 (LBL—6440) **SEEDIS Monitor.** Kreps, P.T.; Sventek, V.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 2 Jun 1977. Contract W-7405-ENG-48. 76p. Dep. NTIS, PC A05/MF A01.

The LBL Socio-Economic-Environmental-Demographic Information System (SEEDIS) consists of a set of program modules for retrieving, analyzing, and displaying selected portions of a very large data base used for environmental impact studies, energy policy analysis, and manpower assessment. The availability of remote access to LBL computers, both dial-up and via the arpanet, created a demand from the user community for a user-friendly interface to the complex data management, analysis, and display modules in SEEDIS. This demand led to the development of the SEEDIS monitor, an executive program which eases the burden of using LBL's complex job control language by performing many routine tasks specified by a simple user command with a few options. The Monitor is designed to provide straightforward access to a collection of SEEDIS modules and to the basic file storage facilities of the BKY operating system. In addition, it provides a local computer mail service for SEEDIS users and on-line help for each module.

13577 (NSO—12) **Correct-program technology/extensibility of verifiers. Two papers on program verification.** Davis, M.; Schwartz, J.T.; Deak, E. (New York Univ., N.Y. (USA). Courant Inst. of Mathematical Sciences). Sep 1977. Contract EY-76-C-02-3077. 150p. Dep. NTIS, PC A07/MFA01.

(I) The problem of finding formal techniques for proving program correctness is addressed. Programming language, proof formalism and proof rules, and code transformation rules are considered. The method is illustrated by proving the correctness of a simple, high-level algorithm, the root form of which is initially described by a succinct, very-high-level text, which is then manipulated systematically and converted by stages into a correct assembly-language version of the same algorithm. (II) A system for verifying programs is discussed. It must not accept a statement as correct unless a proof of it has been accepted by the system. This paper presents a logical prototype of such a system, describes the way in which it could accept general notational extensions of its initial proof formalism, touches on some of the logical issues that arise in connection with the "computerization" of such systems, and analyzes some of the metamathematical questions raised by the method used to achieve extensibility. (RWR)

13578 (ORO—5046-4) **Extension of quasi-Newton methods to constrained optimization and to general systems of nonlinear equations and inequalities. Final report, February 1, 1976—January 31, 1977.** Tapia, R.A. (Rice Univ., Houston, Tex. (USA). Dept. of Mathematical Sciences). [nd]. Contract EY-76-S-05-5046. 8p. Dep. NTIS, PC A02/MF A01.

A theory for extending the popular quasi-Newton secant methods, including the Davidon—Fletcher—Powell method and the Broyden—Fletcher—Goldfarb—Shanno method, for unconstrained minimization to constrained minimization was developed. Since these standard methods must work with positive definite matrices and the usual formulation of the first-order conditions for constrained optimization problems does not lead to a positive definite matrix, a very important part of the theory was the exploitation of positive definite subproblems. The theory is modular, and as a consequence one can now extend an algorithm for unconstrained optimization to constrained optimization in an effective manner.

13579 (SAND—77-1439) **Position-estimation error analysis of a beacon ranging system.** Lyle, W.D. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1977. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

The variance of maximum-likelihood position estimates using a beacon ranging system is derived. Numerical results are presented to illustrate how position accuracy depends on number of beacons and beacon-location errors.

13580 (SAND—77-1492) **General purpose magnetic tape handler.** Bourgeois, N.A. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 13p. Dep. NTIS, PC A02/MF A01.

A recently developed Fortran-callable general purpose magnetic tape handler is presented. The handler operates under the RT-11 operating system on a Digital Corporation PDP-11 family computer. Also included is a sample Fortran program.

13581 (SAND—77-1518) **CDC 6600 subroutine for the logarithm of the gamma function.** Amos, D.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 7p. Dep. NTIS, PC A02/MF A01.

The gamma function is computed on a basic interval (2,3) by a rational Chebyshev approximation and extended to (0,8) by forward or backward recursion. The logarithm of the gamma function on (8,1000) is computed by another rational Chebyshev approximation, and the asymptotic expansion to two terms is used for arguments larger than 1000. Values for nonzero integer arguments up to 100 are stored and returned from a table look-up.

13582 (SAND—77-2024) **User/programmer guide for UCMD 65: adding text from disc to AGS drawings.** Burd, W.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1977. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

This document describes program UCMD 65—an Applicon AGS/870 User Command for adding text from an AGS disc file to an AGS/870 drawing file. 5 figures.

13583 (UCID—17371) **Program manual for the Data Director editor.** McGoldrick, P.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Feb 1977. Contract W-7405-ENG-48. 33p. NTIS, PC E02/MF A01.

The Data Director editor is a powerful, multiuser editor that will aid in the development and modification of APT part programs, assembly-language programs, and other text. Some benefits of the editor are as follows: most of the editor is reentrant, allowing several users to share it; the user can use the editor as though the entire file being edited is in memory; editing takes place on a working file so that changes are not made to the original file until desired; the editor offers a powerful command set where most commands have the same syntax. 1 table.

13584 (UCRL—79790) **Low-power data acquisition with CMOS microprocessors.** Pleva, R.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Jul 1977. Contract W-7405-ENG-48. 6p. (CONF-770985—1). Dep. NTIS, PC A02/MF A01.

From Wescon/77; San Francisco, CA, USA (19 Sep 1977).

At Lawrence Livermore Laboratory, CMOS logic elements, microprocessors, and data converters have been used to implement at least two different ultralow-power data acquisition systems suitable for field applications requiring independence from commercial power sources. One of these systems--the "WISE" package--is designed for monitoring and recording in situ of environmental parameters in harsh environments over a very long period of time (i.e., up to 8 years on a single battery pack). The other system is a general-purpose CMOS computer with analog and digital I/0 which suit it to a wide variety of monitor and control applications, both in the laboratory and in the field. 3 figures.

13585 (UCRL—80228) **Optimal implementation of 2-D nonrecursive digital filters via sectioning.** Twogood, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Nov 1977. Contract W-7405-ENG-48. 30p. (CONF-771206—2). Dep. NTIS, PC A03/MF A01.

From Digital signal processing symposium; Albuquerque, NM, USA (6 Dec 1977).

An optimal sectioning algorithm is presented and completely characterized in terms of both CPU and I/0 requirements. A procedure is then given to enable the optimal choice of sectioning parameters for an arbitrary computer system. This procedure is illustrated for a large scientific computer (CDC 7600), and the sectioning algorithm is shown to be superior to the 2-D FFT implementation for most problems of practical interest. 1 figure, 4 tables.

13586 Quadrature rules for regions having regular hexagonal symmetry. Lyness, J.N. (Argonne National Lab., IL); Monegato, G. *SIAM J. Numer. Anal.;* **14**: No. 2, 283-295(Apr 1977).

D_6-quadrature rules for D_6-regions are investigated. These are two-dimensional rules and regions which have the same symmetry as the regular hexagon. A variant formulation of the standard moment fitting equations is derived. A set of quadrature rules for the hexagon of polynomial degree up to 15 is derived from the solution of these equations. In addition, the same approach yields the corresponding rules for the circle and for two infinite regions, those having weight function e/sup -r2/ and e/sup -r/. A few of these rules, those which represent marginal improvements on rules similarly specified by Stroud [Approximate Calculation of Multiple Integrals, Prentice-Hall, Englewood Cliffs, NJ (1971)], are also listed. 3 tables.

13587 Stability of numerical solution of semi-discrete parabolic equations. Wachspress, E.L. (Knolls Atomic Power Lab., Schenectady, NY). *Comput. Math. Appl.;* **3**: 131-133(1977).

A stability theorem applicable to commonly used numerical techniques for solving semi-discrete parabolic systems of positive-definite type is described.

13588 Jordan representation for a class of nilpotent operators. Gray, L.J. *Indiana Univ. Math. J.;* **26**: No. 1, 57-64(1977).

Let T denote a nilpotent linear operator on a Hilbert space of dimension n; i.e., T/sup k/ = 0 for some integer k. The Jordan form for T says that T is similar to an operator W(W = XTX^{-1} for some nonsingular X) for which there is an orthonormal basis such that We/sub k/ = α/sub k/e/sub k+1/, k = 1, ..., n, and α/sub k/ is either 0 or 1. An operator W of this form is called a 0, 1 weighted shift. W can be written as a direct sum. Let Hamiltonian be a separable infinite-dimensional Hilbert space. A 0, 1 weighted shift may be defined as above, but there is no hope that every nilpotent bounded operator is similar to such a shift. Every 0, 1 weighted shift W satisfies the property that the range of W/sup k/, k greater than or equal to 1, is closed; clearly, not every nilpotent possesses this attribute. This work shows that this necessary condition is also sufficient; if T is nilpotent and the range of T/sup k/, k greater than or equal to 1, is closed, then T is similar to a 0, 1 weighted shift. Some general lemmas about operators X for which X and X^2 have closed range are proved first. These results are applied to the set of all nilpotents such that the range of T/sup k/ is closed for all k to obtain the similarity invariants. Finally, the situation where Hamiltonian is separable is discussed. (RWR)

13589 Interface problem in numerical software. Lyness, J.N. (Argonne National Lab., IL). pp 251-263 of In Proceedings of the sixth Manitoba conference on numerical mathematics. Manitoba, Winnipeg; Univ. of Manitoba (1976).

From 6. Manitoba conference on numerical mathematics; Manitoba, Winnipeg, Canada (29 Sep 1976).

Items of numerical software are normally constructed independently of one another. Significant problems can arise when two or more (individually excellent) items are used in conjunction with one another. A simple problem which illustrates this phenomenon is analyzed here. The problem involves finding the maximum with respect to lambda of an analytic object function F(lambda) defined by means of an integral representation F(lambda) = $\int$ f(x;lambda)dx over the interval from a to b. The numerical solution of this problem would appear to be a straightforward application of an Automatic Quadrature Routine and an Automatic Optimization Routine. However, even when both F(lambda) and f(x;lambda) are eminently well behaved functions, it appears that the "interface problem" is acute, and incorrect results can be readily obtained unless special coding to deal with this interface is included. 2 figures, 1 table.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 11664

13590 (UCRL—80353) **Decision making with interactive access to integrated administrative and technological data bases. (An illustrated conceptual overview).** Hampel, V.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Sep 1977. Contract W-7405-ENG-48. 64p. (CONF-770937—3). Dep. NTIS, PC A04/MF A01.

From ERDA/AESOP 17; Boston, MA, USA (13 Sep 1977).

The Data Management Group at the Lawrence Livermore Laboratory (LLL) is under contract to the Energy Storage Division of the U.S. Department of Energy (DOE/STOR) to establish a computer-based Integrated Information System. This system is intended to support the ongoing RD and D work in this relatively new field of energy research. The bibliographic and numeric reference materials are being compiled for batteries employing aqueous and high-temperature electrolytes, molten salt energy storage, alloys and fiber composites of flywheels, and for hydrogen-based energy storage compounds. The evaluation of these material properties has been subcontracted to nationally recognized data evaluation centers under auspices of the Office of Standard Reference Data at the National Bureau of Standards (NBS/OSRD). Results are scheduled for publication in printed form as a special series of NBS/OSRD, and will be accessible interactively from remote terminals by those who require the latest recommended values. In addition, evaluation criteria on the performance of energy storage systems, being identified by analysts under separate contracts to DOE/STOR, are intended to permit comparative decision making by computer and cost/risk/benefit analyses. The Integrated Information System is configured on a PDP-11/70 computer located at the LLL node of the ARPAnet. Most of the hardware is now installed and operational. The system will be accessible by ERDA/STOR administrators and their contractors over computer networks and by dial-up over telephone lines. Conferencing and electronic mail delivery with a VOTRAX voice synthesizer are in preparation. The system employs the UNIX operating system and uses INGRES as the basic relational approach for data management.

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In the corporate index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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